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MANNING OF RECENTLY FIELDED SYSTEMS:

CASE STUDY OF THE
DD-963 (SPRUANCE) CLASS DESTROYER.

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10) Frans/Nauta
Thomas A./White

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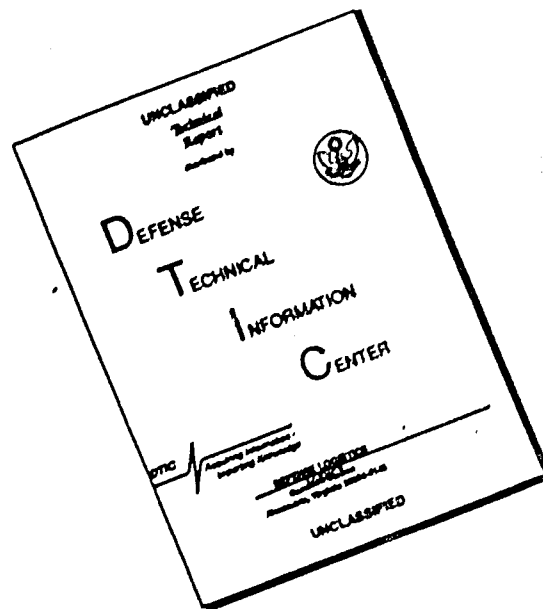
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EXECUTIVE SUMMARY

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When a new system is introduced, the manpower required to operate and support it often does not match the numbers and skill mixes planned during the acquisition process. These mismatches may result from inadequate planning, unanticipated changes in operational and support practices, or deviations of the system's reliability and maintainability characteristics from engineering predictions. Whatever the reason, there is a period after a new system is fielded when it is considered operational but may not have achieved full operational capability due to inadequacies in manpower authorizations, personnel assignments, or school training. Minimizing the duration of that initial period of adjustment is important.

We used the DD-963 (USS SPRUANCE) class destroyer as a case study to learn how and why manpower, personnel, and training requirements change during the early years of a ship's operational life. In doing so, we documented the processes used by the Navy to identify the need for changes, evaluate alternative corrective actions, and verify the adequacy of manpower, personnel, and training. We also explored what could be done to enhance these processes to reduce the delay in attaining full operational capability for future new systems.

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The DD-963 experienced substantial growth in manning requirements during its first five operational years. There were excessive delays in providing adequate technical training for some of the skills aboard the ship due to a lack of training equipment, inadequate analysis of training requirements, and poor feedback of training deficiencies. Most of the manning deficiencies have been identified now that the DD-963 has entered its first overhaul, five years

after commissioning. These deficiencies will be corrected when the ship comes out of overhaul with a hull-specific ship manning document, superseding that previously developed and approved for the entire class.

Some of the DD-963's problems could be attributed to the acquisition strategy, which was a total package procurement. Others, however, were caused by shortcomings in current policies and procedures.

Our case study yielded the following conclusions:

1. The preliminary ship manning document, by its very nature, is not predictive of mature ship manning requirements. It is a point estimate applicable to a particular ship configuration. It reflects the particular viewpoints and constraints of the material developer and does not reflect operational experience with the ship. It always underestimates the final manning requirements of the ship since it does not take into account planned or unplanned configuration changes which add payload; does not compensate for lags in documented workload and is based on optimistic estimates of other workload categories.
2. The need for changes in manning requirements could be reduced by including error or growth margins in the preliminary ship manning document for the baseline estimate of each workload category, and by including the manning impact of planned payload additions.
3. The Navy's ship manpower validation procedure is inadequate. It is not always conducted under realistic conditions at sea. The same procedure used by different people under the same circumstances may result in large differences in validated manning requirements. For example, the DD-964 validated manning requirement was 20 percent in excess of that for the DD-963, both evaluated in port.
4. The organization responsible for validating ship manning requirements is the same one which approves the requirements. The Navy's independent operational testing agent does not test a whole ship (except for small ships), just selected (new) systems installed aboard. The approved manning requirement for a ship is based more on a consensus estimate of acceptable manning than on a true, independent estimate of requirements.
5. The Navy Manning Plan process distributes available manpower assets by rate/rating among Navy-wide authorized billets, resulting in an equiproportional fill of authorizations. A non-linear distribution logic could provide a more effective distribution of manpower Navy-wide.
6. Existing feedback systems permit early identification and correction of operator skills. They also permit, with some lag, identification

of material problems possibly caused by personnel or training inadequacies. However, they do not identify the skill deficiencies of shipboard maintenance personnel. Diagnosis and correction of the skill deficiencies are a lengthy process, requiring on-site surveys by experts, and are limited by available funding to equipments which are in serious trouble Navy-wide.

7. The training needed to attain skill proficiency is so limited by resource constraints that much of it is conducted as on-the-job training aboard ship. The adequacy of this approach depends on the availability of supervisors with the appropriate technical skills. A competent performance of all tasks associated with an electronics system maintenance job can be expected only at the E-6 level. The E-6 inventory is, however, short of requirements in all technical ratings.
8. Delays in the identification, funding, development, and installation of technical training equipment are causing a lack of hands-on training in the schools and have contributed to the poor operational availability of some combat systems aboard the DD-963.

We recommend that the ASD(MRA&L) use his influence and review authority to prompt the Navy to:

1. Improve the ship manpower validation process by requiring at-sea validation of ship manning requirements within one year after commissioning of the lead ship of a class. Manning requirements directly associated with the ship's missions should be validated under auspices of the Navy's independent testing agent. Validation of support manning requirements (facility maintenance, administration/support) may be done by the activity currently responsible, but existing procedures should be improved.
2. Strengthen the process by which training inadequacies are identified and fed back to both the cognizant training and training support agents. Provide the funding and billets as necessary to expand the use of survey teams as the primary vehicle for this feedback system.
3. Place more emphasis during the acquisition process on the identification, development, procurement and installation of training equipment to ensure that needed training equipment will be in place when Navy training courses for new or existing equipments are phased in.
4. Improve the process for estimating mature manning requirements for new ships by including error or growth margins for workload estimates in preliminary manning documents, and by assessing the adequacy of final estimates through a scenario-driven, dynamic simulation model. Until this improvement is implemented, ship manning estimates presented to the DSARC may continue to underestimate mature requirements by a substantial margin.

TABLE OF CONTENTS

	<u>PAGE</u>
EXECUTIVE SUMMARY	ii
LIST OF FIGURES	vii
LIST OF TABLES	viii
<u>CHAPTER</u>	
1 INTRODUCTION	1- 1
Purpose of Case Study	1- 1
The DD-963 Class Destroyer	1- 1
Acquisition Program Overview	1- 5
Observations on Acquisition Strategy	1-11
2 CHANGES IN MANPOWER, PERSONNEL, AND TRAINING.	2- 1
Introduction	2- 1
Manpower Requirements Changes	2- 7
Manpower Authorization Changes	2-25
Personnel Changes	2-26
Training Requirements Changes	2-30
Training Equipment	2-33
3 PROCEDURES FOR IDENTIFYING, EVALUATING AND CORRECTING DEFICIENCIES	3- 1
Introduction	3- 1
OPTEVFOR	3- 1
INSURV Inspections	3- 5
Corrective Action Plan	3- 6
Logistic Reviews	3- 7
Operational Certification Program	3-12
CASREP System	3-15
UNITREP System	3-16
3-M System	3-19
Detection, Action, Response Technique	3-21
Current Ship Maintenance Project	3-25
Fleet Support	3-26
Fleet Inspections	3-30
Professional Advancement Requirements	3-31
Summary	3-31
4 OPERATIONAL AVAILABILITY OF SELECTED COMBAT SYSTEMS	4- 1
Introduction	4- 1
AN/SPS-40B Radar Set	4- 4
Mk86 Gun Fire Control System	4-14
Summary	4-20

TABLE OF CONTENTS (continued)

	<u>PAGE</u>
5 SYNOPSIS, CONCLUSIONS AND RECOMMENDATIONS	5- 1
Why Manning Requirements Change	5- 1
How Manning Requirements Change	5- 3
Estimating Mature Ship Manning Requirements	5- 4
Proper Use of Design Margins	5- 5
Ship Manning Validation	5- 7
Manpower Authorizations	5- 8
Relating Manpower Authorizations to	
Mission Capabilities	5- 9
Sharing of Available Manpower Assets	5-10
Feedback Systems	5-12
Training Requirements	5-14
Training Equipment Funding	5-14
Recommendations	5-16
APPENDIX A - CHANGES IN TRAINING REQUIREMENTS FOR SELECTED SYSTEMS	A- 1
APPENDIX B - THE DEVELOPMENT OF A SHIP MANNING DOCUMENT	B- 1

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LIST OF FIGURES

<u>CHAPTER</u>	<u>PAGE</u>
1-1 Overview of Ship Acquisition Program	1- 8
1-2 Combatant Ship Acquisition Event Phasing and Synchronization	1- 9
2-1 Evolution of Ship Manning Requirements	2-10
2-2 Shipboard Organization Changes	2-18
3-1 Simplified UNITREP Worksheet	3-17
4-1 Skill Levels Versus Maintenance Task Performance	4- 3
4-2 Logistic Support Indicators (Moving Average) for AN/SPS-40B Radar	4- 6
4-3 Operational Availability (A_o) of AN/SPS-40B Radar Set	4- 7
A-1 Typical Phases of EPICS Career	A-13

LIST OF TABLES

<u>CHAPTER</u>	<u>PAGE</u>
1- 1 Ship's Characteristics	1- 2
1- 2 Selected Combat System Specifications	1- 3
1- 3 Comparison of Contract Responsibilities	1-13
2- 1 Key Players in Ship Manpower, Personnel and Training Area	2- 4
2- 2 Comparison of Shipboard Workload Estimates (At Sea)	2-11
2- 3 Enlisted Watchstations (Condition III)	2-16
2- 4 Breakout of PM/CM Estimates (Manhours/ Week, At Sea)	2-19
2- 5 DD-963 (USS SPRUANCE) Enlisted Manpower Requirements	2-23
2- 6 Ship Manpower Authorization (DD-964)	2-26
2- 7 Comparison of Enlisted Personnel Onboard DD-963 and Authorized Manpower by Rate and Rating	2-27
2- 8 Summary of Enlisted Personnel Onboard DD-963 and Authorized Manpower by Pay Grade	2-29
2- 9 Authorized Manpower and Current Onboard Personnel Comparison for Selected NEC's (DD-963 Only)	2-31
3- 1 Example of Corrective Action Plan Information	3- 8
3- 2 Top Fifteen Technical Issues Outstanding for DD-963 Class	3- 9
3- 3 DD-963 Class Fleet Introduction Schedule (NAVSURFPAC)	3-14
3- 4 Equipments on the DART Roster	3-22
3- 5 Deferred Maintenance DD-963	3-26
3- 6 Level of MOTU Technical Assistance (Atlantic Fleet)	3-29
4- 1 Definitions of Logistics Support Indicators	4- 8
4- 2 Summary of SAT Report on AN/SPS-40B/C/D Problems	4-10
4- 3 AN/SPS-40B Manning	4-13
4- 4 Logistic Support Indicators for Mk86 GFCS	4-17
4- 5 Mk86 GFCS Manning Aboard DD-963	4-20
5- 1 Cause-Effect Relationships for DD-963 Manning Changes	5- 3
5- 2 Ratings Aboard DD-963 with Significant Personnel Shortages	5-11
A- 1 Training for Enlisted Personnel - AWHs	A- 3
A- 2 Training Requirements for Enlisted Personnel - AN/SPS-40B Surveillance Radar	A- 5
A- 3 Training Requirements for Enlisted Personnel - Mk86 GFCS	A- 6
A- 4 Propulsion System Training Requirements for Enlisted Personnel	A- 9

List of Tables (Continued)

	<u>PAGE</u>
B- 1 Ship Readiness Conditions	B- 1
B- 2 Required Operational Capability (Extract)	B- 2
B- 3 Watchstation/ROC Relationship Matrix	B- 2
B- 4 POE for DDX Class Ships	B- 3
B- 5 Operating Profile for DDX Class Ships	B- 4
B- 6 Sample Facility Maintenance Standards	B- 7
B- 7 Standard Service Diversion Allowances	B- 9
B- 8 Onboard Training Time Factors	B- 9
B- 9 SMD Procedures	B-11
B-10 Navy Standard Workweek	B-12
B-11 Prescribed Ship Manning Document Contents	B-11

1. INTRODUCTION

PURPOSE OF CASE STUDY

This case study documents manpower, personnel, and training changes for DD-963 class destroyers from fleet commissioning until the first overhaul of the first ship of the class, the USS SPRUANCE. Its purposes are to illustrate the nature and causes of manpower, personnel, and training deficiencies during the early years of a ship's operational life, describe the processes used by the Navy to identify, evaluate, and correct these deficiencies, and analyze the Navy's methods for testing or verifying the adequacy of manpower, personnel, and training.

The reason for putting this factual and analytical information together is to see if Navy policies or procedures could be changed to reduce the cost, delay, and impact on operational readiness of providing new weapon systems with effective manpower, personnel, and training support.

THE DD-963 CLASS DESTROYER

The primary mission of the ship is to provide antisubmarine protection for attack carriers, antisubmarine carriers, amphibious forces, underway replenishment groups, and convoys. Additional missions include shore bombardment and gunfire support for forces engaged in amphibious assault or land warfare; countering surface craft within capabilities; antiair self-defense; and collateral missions normally assigned to destroyers: surveillance, blockade, and search and rescue. The destroyer mission is primarily oriented to task force operations.

The ship is a relatively large platform providing larger growth margins for future weapon systems than any other destroyer previously built. The ship

design is weight-critical, not volume-critical. The key characteristics of the ship are shown in Table 1-1. The combat payload is summarized in Table 1-2. Included in the latter table are equipment modernizations or additions planned for installation on all ships of the class during future overhauls or restricted availabilities (RAVs). (Subsystem additions planned for only a few ships of the class are not shown.)

The DD-963 is a good example of the "pre-planned product improvement" approach to weapon system acquisitions. This planned modernization is subject to change depending on threat assessments and subsystem developments as reflected in the Fleet Modernization Program (FMP).

TABLE 1-1. SHIP'S CHARACTERISTICS

Displacement, tons	- 7,810 (full load)
Length, feet	- 529 (waterline); 563.3 (overall)
Beam, feet	- 55
Draft, feet	- 29
Propulsion	- 4 LM2500 gas turbines at 20,000 shp each; 2 shafts; controllable pitch, reversible propellers
Speed, knots	- 33
Range, naut. miles	- 6,000 (at 20 knots, 2 turbines, 2 shafts) 9,000 (at 17 knots, 2 turbines, 1 shaft trailing)
Accommodations	- 296 (design requirement)(24 OFF/21 CPO/251 OEP)* 341 (SHIPALTs)(24 OFF/21 CPO/297 OEP)**

* OFF = officers; CPO = chief petty officers; OEP = other enlisted personnel.
**SHIPALT = current ship alterations installed during first overhaul.

TABLE 1-2. SELECTED COMBAT SYSTEM SPECIFICATIONS

<u>SCN Funded</u>	<u>Planned Growth/Modernization</u>
<u>Aviation</u>	
2 LAMPS Mk I helicopter equipment*	2 LAMPS Mk III (replacing Mk I)
<u>Weapons</u>	
2 5-inch/54 caliber Mk 45 guns	1 8-inch/55 caliber lightweight gun (Mk 71)(replacing forward 5-inch mount)***
1 NATO SEA SPARROW 8-tube launcher (Mk 29)*	1 multi-purpose guided missile launcher (Mk 26)(replacing Mk 16 and Mk 29 launchers)
1 ASROC 8-tube launcher (Mk 16)	2 PHALANX close-in weapon systems (Mk 15 Mod 2)
2 quadruple HARPOON missile cannister launchers*	
2 triple-tube torpedo launchers (Mk 32)	
<u>Fire Control</u>	
1 Mk 86 Mod 3 GFCS	1 target acquisition system (TAS) (Mk 23)
1 Mk 116 Mod 0 UWFCs	
1 Mk 91 GMFSC*	
<u>Sensors</u>	
1 AN/SPS-40B air search radar	1 infrared search and track (IRST)
1 AN/SPS-55 surface search radar	
1 AN/SPG-60 air target tracking radar	1 tactical towed array sonar (TACTAS) (AN/SQR-19)
1 AN/SPQ-9 surface target tracking radar	
1 AN/SQS-53 SONAR (bow mounted)	
<u>Countermeasures</u>	
1 AN/SLQ-25 NIXIE torpedo countermeasures*	
1 AN/WLR-1 and -11*	1 AN/SLQ-32 (replacing AN/WLR-1 and -11)
1 Mk 36 Chaff decoy launcher (RBOC)**	
<p>* Equipment on first set of ships was not installed during construction, but retrofitted during RAV or overhaul; it was installed during construction on final set of ships.</p> <p>** Replaces earlier planned Mk 33 CHAFFROC.</p> <p>*** The Major Caliber Lightweight Gun (MCLWG) program was suspended August 1978. The Navy has indicated plans to install a 8-inch gun when it becomes available.</p>	

The combat system is highly automated, Naval Tactical Data System-based, and integrated by means of a command and decision subsystem (CDSS). It comprises the ship operational program, which consists of the following: 21 modules, 124,000 instructions, and 83,000 words of data (basic version prior to missile integration); the AN/UYK-7 computer group, which includes 3 central processors, 2 input/output controllers, 8 memory units and various peripherals; and a total of 10 AN/UYA-4 data displays. CDSS integrates the following subsystems:

- surveillance radar and AIMS (including the AN/SPS-55B surface search radar, the AN/SPS-40B air search radar, and the AIMS Mk XII interrogator/transponder)
- weapons and weapons control (the Mark 86 Mod 3 gunfire control system controlling the two Mark 45 lightweight 5-inch/54-caliber guns; the new digital underwater fire control system, Mk 116, developed as part of the DD-963 program for control of the Mark 16 ASROC launcher, the two triple-tube Mark 32 torpedo launchers, and the helicopter-launched weapons; and the Mk 91 guided missile fire control system for the HARPOON missiles)
- underwater surveillance and communications (including the AN/SQS-53 sonar)
- external communications (NTDS data link 11, link 14, TTY circuits, COMSEC equipment, a new message processing system, 3 LF/MF receivers, 1 MF transmitter, new HF equipment including 7 transmitters and 12 receivers, 3 VHF and 8 UHF transceivers)
- interior communications
- navigation (including AN/SRN-12A Omega receiver, AN/SRN-18 satellite navigation receiver, electromagnetic log, Mark 19 gyroscope)

The propulsion system is composed of two plants arranged in separate main engine rooms forward and aft of the two adjacent auxiliary machine rooms. Each plant has two gas turbines driving one shaft and a controllable-pitch, reversible propeller. The propulsion system can be controlled locally or centrally; central control is either from the bridge or from the central control station. The latter includes damage control as well as engineering control.

The electrical system includes three 2,000 kw gas turbine generators, one installed in each machinery space with the third in a separate generator room. Three 150 kw solid state power converters provide 400 Hz power to the combat system (two are needed; one is standby). The electrical system is controlled from the central control station.

Auxiliaries include equipment for environmental control, fluids (fuel, fire protection, bilge drain, fresh water, compressed gas, waste disposal), maneuvering, underway replenishment, strikedown and stores handling, and helicopter support.

ACQUISITION PROGRAM OVERVIEW

The DD-963 program began as the DX/DXG program, initiated in December 1966 to replace obsolete World War II destroyers. The program applied the concept formulation/contract definition (CF/CD) acquisition strategy introduced by Secretary of Defense McNamara in 1966. It was also one of the first ship acquisition programs in the Navy under project management.

Concept formulation took about one year. During this phase, the Navy conducted hundreds of trade-off studies to determine optimal ship performance requirements based on cost (acquisition and operating)-effectiveness (quantification of military performance) analysis of all alternatives. In support of this effort, the ship synthesis model developed by the Naval Ship Engineering Center was utilized. This model was designed to estimate ship size based on a "shopping list" of shipboard equipments and performance requirements. Over 1,000 model runs corresponding to alternative ship configurations were made during the DX/DXG concept formulation. The concept phase resulted in (1) the top-level requirements for a multi-purpose destroyer (DX) design which became the DD-963 (SPRUANCE) class, and (2) the decision that the best guided missile nuclear frigate (DXG) was similar to the existing DLGN-36 (CALIFORNIA) class

design which therefore was to be continued; this similar design became the CGN-38 (VIRGINIA) class.

With Secretary of Defense authorization to proceed into the contract phase for the DX, a request for proposal (RFP) was issued by the Navy in February 1968. The RFP solicited proposals for a preliminary design effort for a destroyer meeting the stated requirements at least life cycle cost, and development of a production plan and cost estimate for building the ships. Based on the preceding concept formulation results, the RFP specified in detail the weapons and electronics configuration of the ship and the required ship characteristics (maximum speed, cruise speed, range, and sea-keeping requirements). Six shipbuilders responded with proposals by May 1968. In July, three (General Dynamics, Litton Industries, and Bath Iron Works) were awarded \$10 million contracts to compete in the contract definition effort. The key design variable was the type of power plant, which also affected hull form. With the Navy requirements defined, the only other design variable affecting life cycle cost was ship manning--a decision which could be separated from vessel configuration decisions since the ship was not volume-limited, but weight-limited (Devanney, 1975).

Submission of the hull design was due in December 1968 to give the Naval Ship Research and Development Center (NSRDC) time to develop 20-foot models and test hull performance (verifying contractor claims). The detailed contract designs and associated construction bids were due in April 1969. Thus the contractors had less than four months to decide upon the key design variable (power plant) and complete the hull design, and feedback from NSRDC testing could not be incorporated in the proposed contract designs. (Devanney, 1975). All three competing contractors proposed gas turbine propulsion.

Following an extensive Navy review of the competing designs and bids, General Dynamics was eliminated from competition in September 1969. Negotiations with the two finalists continued into 1970. One of the main problems was that both bids were well above Navy expectations. To lower the bids, negotiated adjustments were made in the design requirements, eliminating some of the specified equipments from the design, making some of them Government-furnished equipment. Also, reductions were made in the contractor's estimates of such things as training requirements. After a delay of about one year, the contract definition phase terminated in May 1970. A Defense System Acquisition Review Council (DSARC) review on 28 May authorized proceeding with the construction of the 30-ship class, and in June 1970 Litton Industries was awarded the total package procurement (TPP) contract.

The delivery dates of the ships are shown in Figure 1-1. It also shows the ship development phases under current ship acquisition policies, including typical durations of these phases for surface combatants (Johnson, 1980). The current relationship between the ship design phases and the DSARC process is shown in Figure 1-2, which is adapted from NAVSEA Instruction 9060.4, March 1976. As indicated above, the only DSARC convened for the DD-963 program was the production milestone (DSARC III) in May 1970.

The acceptance trials of the DD-963 took place in July 1975. The ship was delivered to Commander, Naval Surface Force, U.S. Atlantic Fleet (SURFLANT) in August and commissioned in September 1975. Final contract trials took place in March 1976, followed by a post-shakedown availability to correct deficiencies found by the Board of Inspection and Survey. From June through December 1976, the ship had its first restricted availability (RAV) for installation of equipment not included in the original construction contract (but for which space and weight reservations had been made in the

FIGURE I-1: OVERVIEW OF SHIP ACQUISITION PROGRAM

DD - 963 CLASS

1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
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CURRENT PROCESS (NOTIONAL)

FEASIBILITY STUDIES



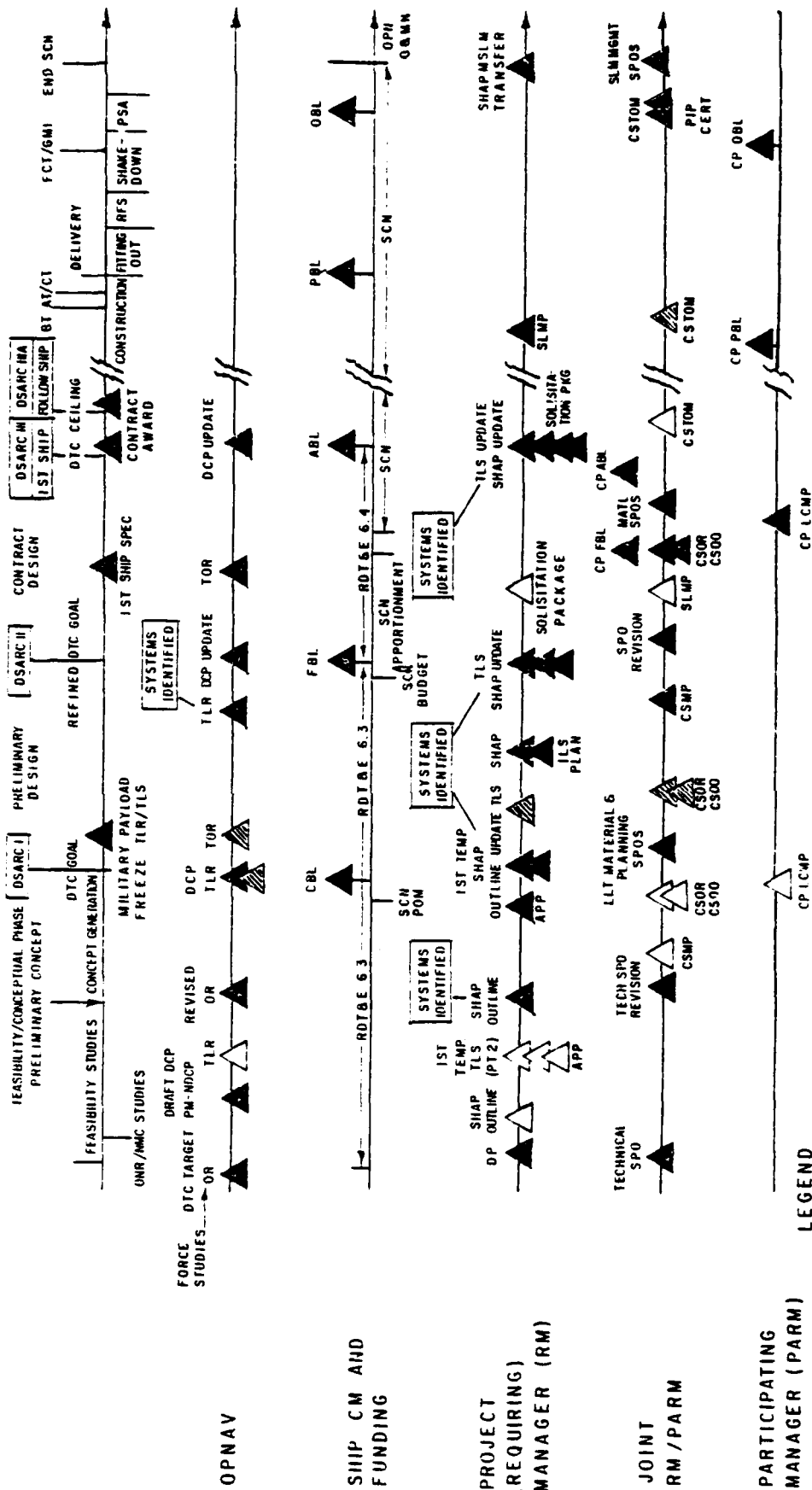
CONCEPTUAL DESIGN

LEGEND

- AT = ACCEPTANCE TRIALS
- BT = BUILDERS TRIALS
- CF = CONCEPT FORMULATION
- CD = CONTRACT DEFINITION
- FCT = FINAL CONTRACT TRIALS
- SCN = SHIPBUILDING AND CONVERSION, NAVY
- TPP = TOTAL PACKAGE PROCUREMENT

FIGURE 1-2. COMBATANT SHIP ACQUISITION EVENT PHASING AND SYNCHRONIZATION

(REPRESENTATIVE)



LEGEND

- △ BEGIN
- ▴ PRELIMINARY ISSUE
- ▲ ISSUED OR EVENT

SOURCE: NAVSEA INSTRUCTION 9060.4, 30 MARCH 1976

design), as identified in Table 1-2. In April 1977, the Shipbuilding and Conversion, Navy (SCN) funding envelope for the DD-963 terminated, and responsibility for ship support was transferred from the ship acquisition project manager (SHAPM) to the escort/cruiser ship logistic division within the Naval Sea Systems Command (NAVSEA 934; now the surface combatant ship logistic division, NAVSEA 931) referred to as the ship logistic manager (SLM).¹ (By law, SCN funding terminates 11 months after completion of "fitting out", i.e., placing onboard the materiel specified in the ship's allowance lists, which was completed during the fitting out period per Navy approved baseline configuration in May 1976).

The second ship of the class, DD-964 (USS FOSTER), was delivered to Commander, Naval Surface Force, U.S. Pacific Fleet (SURFPAC) and commissioned in February 1976, five months after the DD-963. (Current practice is to provide a one-to two-year leadtime between delivery of the leadship of a new class and the first followship.) Management responsibility was transferred from the SHAPM to the SLM in May 1977.¹ The 30th and final ship of the class, DD-992 (USS FLETCHER), was commissioned in July 1980. (An additional ship was authorized by Congress in 1978 for delivery in 1984.) Delays in ship deliveries from the original 1970 schedule were less than two years for the final ships.

The first operational cycle of the DD-963 terminated in August 1980, when the ship went into its first overhaul five years after commissioning, as planned.

¹As an exception to standard policy, logistic management was later returned to the SHAPM organization (PMS-389).

OBSERVATIONS ON ACQUISITION STRATEGY

Because the Navy has attributed many of the DD-963 manning problems described in the next chapters to the acquisition strategy, some brief comments on this subject are in order.

The acquisition strategy was a competitive contract definition (CD) followed by a total package procurement (TPP) contract for the detail design and construction of the entire class. CD, in effect, transferred preliminary and contract design from the Navy to the private sector. (For the DD-963 class, however, the Naval Ship Engineering Center did perform a preliminary design in order to establish the baseline used in evaluating the competitive contract designs). TPP was introduced by the Department of Defense to replace the incremental procurement of research and development, test and evaluation, production and logistic support requirements. Under TPP, a single contract containing price and performance commitments covers development, testing, production and as much support as is feasible. The pros and cons of TPP, especially the way it was implemented DoD-wide, have been discussed extensively in the acquisition literature. In 1970, TPP was discontinued and replaced by the acquisition strategy spelled out in DoDD 5000.1.

The DX program was the third ship acquisition program to go through CD; it was preceded by the Fast Deployment Logistic (FDL) and the amphibious assault (LHA) ship acquisition programs. The DD-963 was the Navy's second TPP contract (the FDL program was cancelled). As a result of the early experiences with the LHA contract, the Navy viewed the DD-963 contract as a hands-off situation requiring maximum disengagement by the Government. Based on testimony before Congress, it is clear that the number of Navy-directed changes was, in fact, minimal.

The DD-963 TPP contract transferred to the shipbuilder many of the responsibilities traditionally held by the Navy. Table 1-3 compares the contractual responsibilities for the DD-963 and DD-993, indicating that for the DD-963 program, the shipbuilder, not the Navy, had the key responsibilities for determining manpower and training requirements. The DD-993 (KIDD) class is a DD-963 platform with added area antiair warfare combat capability. It was not a "typical" acquisition program because it resulted from cancellation of an Iranian Foreign Military Sales agreement. Nevertheless, the contractual responsibilities for that ship are more representative of those in effect during the pre- and post-TPP era. Today, system design is actually done by the shipbuilder, but subject to Navy review and approval prior to detail drawings. Other items, such as ILS and training typically are contracted for separately from ship construction; they may be delivered by the shipbuilder, another contractor, or Navy activity, but are subject to review and approval by the Navy chain of command.)

In summary, the net effect of the TPP contract on DD-963 manning and training was to delay the Navy's active involvement in changing manning and training requirements because of the perceived risk of litigation. As discussed in the next chapter, the TPP contract included a low ceiling on ship manning as a result of the emphasis on minimizing life cycle costs. The contract also included a guarantee and warranty clause conditional upon the Navy's adhering to the contractor-determined training requirements and ship manning (rate/rating) requirements as called out by the contractor's Plans for Maintenance of the ship.

TABLE 1-3. COMPARISON OF CONTRACT RESPONSIBILITIES

	<u>DD-963</u>	<u>DD-993</u>
System Design	Ingalls	Navy
Detail Design	Ingalls	Ingalls
Performance of ship	Ingalls	Navy
ILS	Ingalls	Navy
Software	Ingalls	Navy
Training plan/training	Ingalls	Navy
Baseline configuration control	Ingalls	Navy
Trials	Ingalls	Ingalls
Fitting out	Ingalls	Navy/Ingalls
Guarantee/warranty	12 months/48 months after 5th ship	6 months after fitting out/8 months after acceptance
Post delivery trials	Ingalls	Navy
Test procedure GFE	Ingalls	Navy
Test procedure CFE	Ingalls	Ingalls

Source: Testimony by Fred W. O'Green, President, Litton Industries, Inc., (parent company of the Ingalls Shipbuilding Division, Pascagoula, Mississippi), before subcommittee on Department of Defense, Committee on Appropriations, House of Representatives, March 23, 1977.

2. CHANGES IN MANPOWER, PERSONNEL, AND TRAINING

INTRODUCTION

This chapter describes the changes in ship manning requirements, manpower authorizations, on-board personnel, and training which occurred during the first operational years of the DD-963, and the reasons for them. Ship manning requirements are identified by the ship manning document (SMD). The Navy has a well-established procedure for developing SMDs (OPNAV 10P-23). The same procedure is used to develop preliminary estimates (PSMD) during ship development and to determine the final SMD after operational experience with the ship. (The process is explained in Appendix B.) The SMD process is designed to define the minimum wartime shipboard manning requirements, unconstrained by manpower availability or berthing accommodations. For a new class like the DD-963, the original, approved SMD is a class document; once the ships of the class go through first overhaul, they receive hull-specific SMDs which may differ from one another, reflecting different configurations and mission requirements.

Manpower authorizations (MPA) are identified in OPNAV Form 1000/2 issued for each operational ship in the Navy. This form identifies the ship's force (by rate, rating, and NEC) authorized for the ship (within the allocations of the Military Personnel, Navy appropriation for the current, budget and program years), as well as the mobilization requirements (typically identical to the SMD). Normally, the MPA is less than or equal to the SMD, but for new construction ships, the MPA may authorize more billets during the first operating cycle. The MPA is more responsive than the class SMD because it can be changed without going through the lengthy approval cycle required for SMD

changes. The MPA may be viewed as more truly reflective of minimum ship manning requirements than the SMD. If a manning increase is really necessary, the fleet will fight for a MPA change and normally get it.

Due to imbalances between the personnel inventory and manpower authorization by rate, rating, and NEC, on-board personnel normally does not match authorizations. A ship's pro rata share of the personnel inventory by rate and rating is identified by the Navy Manning Plan (NMP). The NMP for any unit is the outcome of a computerized process in which a seven-month projection of the personnel inventory is allocated to the manpower authorizations for all Navy units, taking into account differential manning priorities for certain categories of units (e.g., strategic systems and new construction ships during their first operational years). The NMP for a ship like the DD-963 may show overages and/or shortages by rate/rating (NECs are not reflected in the NMP), but in total will be close to the average Navy-wide fill of authorizations (about 95 percent). The NMP, however, does not represent a guarantee by the personnel system; the number of actual on-board personnel may be different for a variety of reasons (unplanned attritions, training shortfalls, reassignment ineligibility based on sea/shore rotation, etc.). Specifically, while the personnel detailers attempt to match NEC requirements identified by the MPA, their ability to do so is constrained by many personnel and training factors. The Enlisted Distribution Verification Report identifies the actual personnel assigned aboard ship.

Training requirements for a ship are identified by the Navy Training Plan (NTP) for the ship class, developed in parallel with the PSMD. This document defines what training is required for each billet by referring to existing courses or identifying new course requirements. In essence, it combines existing NTPs (which are developed for each major subsystem) for subsystems

installed on-board, adds "A" and/or "C" School or Fleet Training Center courses from the Catalog of Navy Training Courses for billets not included in existing NTPs, and identifies ship-peculiar training requirements for which new courses must be developed or existing courses modified (new systems or new equipments which may or may not be peculiar to the ship class).

Prior to approval in final form, both the draft NTP and (P)SMD go through a lengthy review process involving all cognizant agencies, including the fleet. (The formal process includes a number of NTP and SMD conferences, respectively; final NTP approval is by the Training Resources Panel). If a new rating or skill identifier (NEC) is called for in these documents, they must be approved separately by the Rating Review Board. Like the SMD, the NTP is a requirements document. Once approved, its actual implementation and execution are affected by budgetary limitations (funded trainee billets, school capacities, training equipment) and personnel availability (recruiting shortfalls, attrition, etc.).

The key players and their responsibilities in the manpower, personnel, and training area are summarized in Table 2-1. Briefly, the Deputy Chief of Naval Operations (DCNO) for Surface Warfare (OP-03) is the program sponsor. He chairs the Ship Acquisition and Improvement Panel and sponsors the SCN appropriation. He is responsible for drafting the decision coordinating paper required for a surface ship acquisition program, establishing the mission requirements and top-level requirements (TLR), and determining required operational capabilities (ROC), projected operational environment (POE), and operational profile (or plan for use). As participant in the Program Objective Memorandum (POM) process, he also determines the billet authorizations for the ship. He convenes and chairs the NTP conference and, as resource

TABLE 2-1. KEY PLAYERS IN SHIP MANPOWER, PERSONNEL AND TRAINING AREA

ORGANIZATION	KEY RESPONSIBILITIES IN M/P/T AREAS
DCNO (Surface Warfare) (OP-03)	Develop OR; DCP; ROC, POE, operational profile Coordinate development of SMD, NTP Review draft (P)SMD, NTP Program billet, trainee and training resource requirements (POM) Review or initiate MPA change requests (Form 1000/4)
DCNO (Manpower, Personnel and Training) (OP-01)	Monitor and approve PSMD, draft NTP Coordinate development of draft SMD Approve or modify SMD Issue OPNAV Form 1000/2 (approved and funded billets) Approve MPA change requests (OPNAV Form 1000/4) Responsible for officer/enlisted classification codes Program individuals (transients, patients, prisoners) account (POM)
Project Manager (PMS-389) (originally PM-18)	Develop PSMD, draft NTP Develop new course material and training equipment Develop ILS plan
Navy Manpower and Material Analysis Centers (NAVMMAC/PAC/LANT)	Develop staffing standards Perform on-site surveys (SMD validation) Develop draft final SMD
Operational Test and Evaluation Force (OPTEVFOR)	Conduct OPEVAL for new subsystems prior to approval for service use
Board of Inspection and Survey (INSURV)	Conduct material condition inspections at AT, FCT, and post-deployment (approximately once every 3 years), including deficiencies caused by M/P/T deficiencies
DCNM (Logistics) (MAT-04)	Chair NAVMAT Logistics Review Group Provide intensive management of selected equipments (DART program)
Surface Combatant Ships Directorate (NAVSEA-93)	Perform logistic audit of ship Manage material support to the ship Responsible for resolving reliability/maintainability problems (including engineering changes, product improvements, documentation and training course improvements)
Naval Military Personnel Command (NMPC)	Prepare NMP projections Assign personnel to training and authorized billets Document personnel assignments (EDVR)
CNET	Approve training plans for A or C schools not covered by NTPs Program instructor and student billets within funding constraints Implement/execute NTP
Fleet (CINCs, TYCOMs, COs)	Review draft SMD, NTP Initiate MPA change requests (OPNAV 1000/4) Conduct readiness evaluations and training exercises Provide feedback data (UNITREP, CASREP, 3-M System)
Fleet Support (FLETRACEN) (MOTU, MTT) (NAVSEACEN and other)	Conduct fleet training (school or pier-side) Provide OJT for electronics and weapons Provide technical assistance

sponsor, has approval authority of the NTP and (P)SMD. Final approval authority for manning and training requirements, however, rests with the DCNO for Manpower, Personnel, and Training (MPT) as mission sponsor. The latter also issues OPNAV Form 1000/2 for each ship, reflecting the authorized and funded billets as determined at completion of the annual POM process, and approves any manning changes requested outside of the POM cycle via OPNAV Form 1000/4 (an approval which normally requires claimant in-grade compensation).

Within the Naval Material Command (NAVMAT), the ship acquisition program manager (SHAPM) develops the draft PSMD and NTP. The Commander, Naval Sea Systems Command (COMNAVSEA) is responsible to the Chief of Naval Material (CNM) for ship acquisition. COMNAVSEA conducts a logistics audit of the ship class and manages material support for the life cycle of the ship, aided by commodity managers in other systems commands and field activities. The Deputy Chief of Naval Material (DCNM) for Acquisition (MAT-08) reviews new acquisition programs and chairs the Acquisition Review Group (ARG). The DCNM for Logistics (MAT-04) chairs the logistic review group (LRG) to evaluate adequacy of logistic planning and manages the Detection, Action, and Response Technique (DART) program to resolve Navy-wide material deficiencies (including those caused by improper training).

The roles of the remaining organizations displayed in Table 2-1 are self-explanatory. Feedback from the fleet comes from more than just the standard channels listed: unit readiness reporting system (UNITREP), casualty reporting system (CASREP), and the maintenance and material management (3-M) system. These and other forms of feedback, such as message traffic which may identify manpower/personnel/training deficiencies, are discussed in Chapter 3. Under fleet support, the table only identifies a few: Fleet Training Centers

(FLTRACEN), mobile technical units (MOTU), Naval Sea Support Center (NAVSEACEN) and mobile training teams (MTT). There are numerous other support activities, both fixed (e.g., engineering stations) and mobile (e.g., ship assist teams), which provide technical assistance to the fleet, but their functions do not normally include on-the-job training (OJT). Technical assistance is beyond the scope of this study, except insofar as the extent of technical assistance provided to the ship may be an indicator of ship manning, personnel, and training deficiencies.

Table 2-1 displays the key manpower, personnel, and training responsibilities under today's acquisition policies and functional organization. The peculiarities of the DD-963 program (a TPP program) as well as its timeframe (contract award in 1970) caused considerably less scrutiny of the manpower, personnel, and training requirements planning than a similar program would receive today. Recent reorganizations within OPNAV and NAVMAT have strengthened the review of manning implications of new ship acquisitions. Following the HARDMAN study in 1977, the role of the DCNO (Manpower) was expanded. He is now the DCNO (MPT) and a full member of the Department of the Navy System Acquisition Review Council (DNSARC). Prior to that time, manning and training requirements were under the sole purview of the program sponsor and the material developer. Similarly, the ARG and LRG were created by CNM in 1978.

In the absence of an integrated logistic support (ILS) plan for the DD-963 and as a result of the terms of the TPP contract, it was only after delivery that the Navy hierarchy got seriously involved in the manpower, personnel, and training requirements of the class. Until that time, the personnel and training community reviewed Litton's manning and training plans (PSMD and NTP drafts), but was under directions not to deviate from those

plans to avoid possible litigation. This was explained by the guarantee and warranty provisions of the contract. Both the performance, maintainability, and guarantee article and the warranty period article stipulated that the provisions would not be applicable to "deficiencies caused by failure of the Government to perform maintenance in accordance with the Plans for Maintenance." The Navy was anxious not to relieve the shipbuilder of his contractual liabilities and, therefore, was committed to the training courses and rate/rating requirements called out by the Plans for Maintenance.

The guarantee (concerning design or engineering deficiencies) extended for 48 months of unrestricted service after final acceptance of the fifth vessel. The warranty (concerning material and workmanship) was for 12 months of unrestricted service after delivery of each ship.

Under the terms of the contract, Litton was required to provide the following ship manning and training data:

- semi-annual updating of the PSMD per 30 September and 30 March (first submittal April 1971)
- semi-annual updating of Operational Stations Book (OSB) per 30 October and 30 April (first submittal October 1970)
- documentation of watch, quarter and station bill (submittal July 1974)
- ship training plan and modifications as necessary (first submittal November 1970)
- training program schedule and updates in accordance with PSMD changes (first submittal August 1971)

In addition, Litton conducted combat team training for the first five crews, and orientation/indoctrination (O/I) training for the first seven crews. All contractor courses were terminated by the end of fiscal 1976 with Navy take-over of all training responsibilities.

MANPOWER REQUIREMENTS CHANGES

One of the design approaches applied by Litton to reduce the life cycle

cost of its proposed contract design was an austere ship manning level. This was subsequently reflected in the TPP contract, which included a manning ceiling of 247 (18 officers (OFF)/17 chief petty officers (CPO)/212 other enlisted personnel (OEP) or 229 total enlisted personnel) and design accommodations for 296 (24 OFF/21 CPO/251 OEP). The design accommodations provided for an antisubmarine warfare helicopter detachment aboard (4 OFF/1 CPO/14 OEP) and an additional 10 percent growth margin, which is customary in ship design (OPNAV Instruction 9336.6: "Accommodation Derivation for Ships of the U.S. Navy," 3 August 1970). As indicated earlier, the original contract did not include much of the equipment installed onboard these ships today. The only combat systems included were the sonar, ASROC and torpedoes with associated fire control system; the guns and associated fire control system; the air and surface search radars; and NTDS. For all other equipments (see Table 1-2), the ship design included space and weight reservation margins; the manning implications were not included in the manpower ceiling but had to come out of the growth margin. It was not until December 1974 that final decisions were made by the CNO as to which equipments should be installed aboard after delivery of the ships. (These final decisions pertained to installation of HARPOON, provision of a full-up LAMPS capability requiring additional cabling and acoustic processor (AN/SQR-17) on all ships, and installation of intelligence gathering equipment (OUTBOARD) aboard three ships. Additional OUTBOARD installations were subsequently decided in 1977 and 1980).

As a result of the terms of the contract, Litton had sole responsibility for the development of PSMDs. Eight PSMDs were delivered by Litton to the SHAPM between 1970 and 1976. They showed very minor variations from each other, and, of course, all were within the contract ceiling. PSMD #7 was dated June 1975 (just prior to acceptance trials). The final PSMD of May 1976

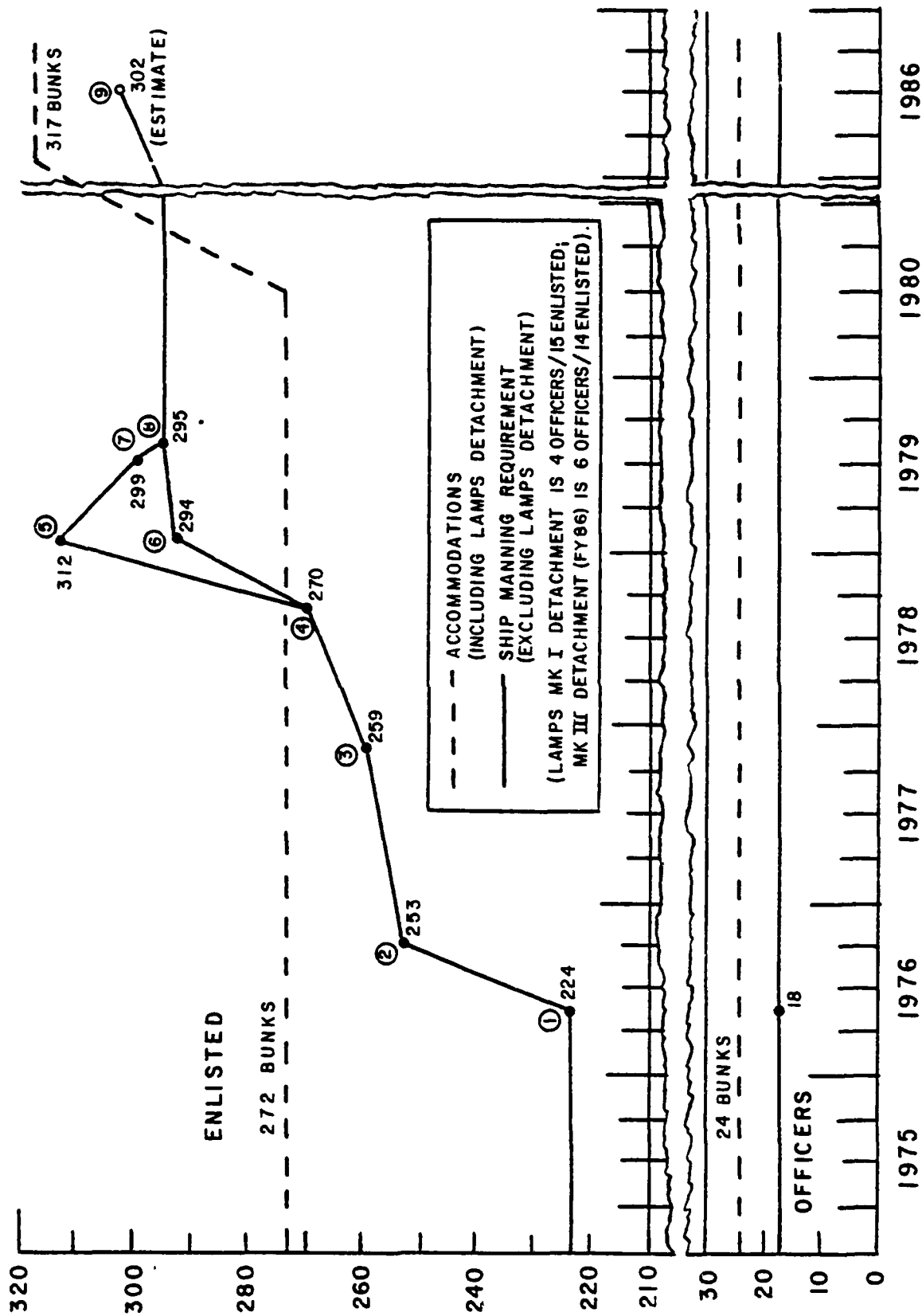
(after final contract trials) did not introduce any quantitative changes to PSMD #7, but accommodated Navy comments on previous versions.

Our story thus begins with an austere manning estimate developed by the contractor subject to a contractual ceiling, and traces the subsequent growth in manning requirements as identified by various changes in PSMDs and draft SMDs (see Figure 2-1). A comparison of the associated workload estimates, keyed to the same documents, is shown in Table 2-2.

Document #1

This was the final PSMD prepared by the shipbuilder in May 1976. It reflects the Navy-approved baseline configuration of the ship. The document adhered fully to standard procedures (OPNAV 10P-23) and provided detailed backup data for all workload estimates, including an analysis of in-port (Condition V) manning. Compared to other PSMDs we have seen for other ship acquisition programs, it was a professional product. Preventive maintenance (PM) was documented by means of Maintenance Index Pages (MIPs) and Maintenance Requirements Cards (MRCs) for existing equipments or Logistic Support Analysis (LSA) for new equipments. Corrective maintenance (CM) was based on empirical data as documented by the 3-M system for existing equipments installed aboard similar ships or estimates from vendors for new equipments, using estimated operating hours from the steaming profile included in contract specifications. The entire maintenance engineering analysis included 2,165 items, 280 of which were covered by existing MIPs. A make-ready/put-away (MR/PA) allowance was provided in accordance with 10P-23 (30 percent of the sum of PM and CM). Facility maintenance (FM) was computed from industrial time factors for each FM task, estimated task frequency and surface area involved. Own unit support (OUS) comprising both administration/support and utilities/evolutions were

FIGURE 2-1. EVOLUTION OF SHIP MANNING REQUIREMENTS



NOTE: ⑧ REFERS TO PSMD OR DRAFT SMD IDENTIFIED IN TEXT

TABLE 2-2. COMPARISON OF SHIPBOARD WORKLOAD ESTIMATES (AT SEA)

DOCUMENT IDENTIFICATION	SHIP'S FORCE BILLETS						ENLISTED PERSONNEL WORKLOAD EXCLUDING LAMPS DETACHMENT										EXCESS AVAILABLE MI/WK	
	Total	OFF	Enlisted			Condition III Sta.	Operational Manning (mh/wk)	Non-Operational Manning (mh/wk)					Total Workload					
			CPO	PO	Strik.			Non-R	Total	PM	CM	PM		OOS	PA	SD&T		
1. Final PSMD, Litton May 1976	242	18	17	128	29	58	224	33	99	5,544	1,182	364	1,500	2,229	715	1,199	12,732	2,844
2. Interim Change #1, OP-124, Sept. 1976	271	18	17	143	32	61	253	40	120	6,720	N/A	N/A	1,700	N/A	N/A	1,338	N/A	N/A
3. Draft SMD DD-963, NAVMACLANT, Nov. 1977	277	18	17	158	45	39	259	44	132	7,392	993	397	1,377	2,632	1,080	1,356	15,226	2,924
4. Final SMD for Class, OP-124, Aug. 1978	288	18	18	163	43	46	270	49	147	8,232	1,725	710	1,393	2,715	1,289	1,400	17,463	1,531
5. First Draft SMD DD-964, NAVMACPAC, May 1979	330	18	22	178	47	65	312	49	147	8,232	2,451	1,019	1,934	3,489	1,755	1,652	20,532	1,236
6. Revised Draft SMD DD-963, NAVMACLANT, May 1979	312	18	21	173	48	52	294	49	147	8,232	2,217	861	1,644	3,096	1,540	1,544	19,133	1,447
7. Final Draft SMD DD-964, NAVMACPAC, July 1979	317	18	23	174	47	55	299	49	147	8,232	2,234	907	1,825	3,440	1,657	1,574	19,867	1,043
8. Final Draft SMD for Class, OP-111 (not approved as of December 1980)	313	18					295	49	147	8,232	N/A	N/A	N/A	N/A	N/A	1,550	N/A	N/A

Note:

1. Data excludes LAMPS detachment consisting of 4 OFF/15 ENL (MR 1) or 6 OFF/14 ENL (MR 111) and any workload assigned to the LAMPS detachment.
2. Numbers may not add due to rounding.
3. MR/PA allowance included in PM; OOS comprises A/S and UT.

estimated from detailed surveys aboard other ships and analyses of utility/evolution task requirements. A productive allowance (PA) of 20 percent of all productive work (i.e., the sum of all workload components except watchstanding) was added in accordance with 10P-23, as well as an allowance for service diversions and training (SD&T) (4.5 hours/week for watchstanders; 6 hours/week for non-watchstanders as prescribed by 10P-23). The last column in Table 2-2 shows available manhours/week not allocated to operational manning or documented workload; this figure is derived from the standard Navy work week at sea (see Appendix B).

Litton's manning estimate was austere. Worthy of note are the following critical observations:

- The proposed manning relied on an unproved, automated alarm system to eliminate the need for watchstations in the engineering spaces.
- An optimistic assessment of FM requirements assumed high quality surface coatings and efficient work performance would reduce FM workload; neither assumption was realistic. The FM area, in excess of 500,000 sq. ft., is double that on the DE-1052, but was estimated to require only 1500 hours/week maintenance compared to the DE-1052's 1300 hour/week requirement. Interior bulkheads amounting to 214,000 sq. ft. were supposed to be covered with a stick-on coating eliminating need for painting, but the coating turned out to collect dirt which could not be hosed off so that bulkheads are, in fact, being painted. Industrial standards do not necessarily apply aboard ship.
- Estimates of the planned maintenance requirements were optimistic, especially for the gas turbine propulsion system. (Little test data had been accumulated at that time for the marinized version of General Electric's LM 2500 gas turbine. Litton's estimates had to be doubled later on.)
- No CM requirements were identified for the Repair Division in the Engineering Department (HT rating). CM requirements are now estimated at 180 hours/week.
- Estimates of CM requirements were made unrealistically low by eliminating from the data base any maintenance actions with an unusually long repair time--3-M data which were presumed to be in error. Also, Litton did not adhere to 10P-23 guidance requiring addition of 0.25 hours for each maintenance action if empirical data are used for predicting CM requirements.

- There was no productive allowance for many billets workloaded with FM or administration/support, resulting in shaving up to 340 hours off documented workload (715 hours for PA vice 1,055 resulting from a 20 percent factor applied to the non-operational workload).
- Even though documented PM workload (including MR/PA allowance) was in excess of 1,000 hours/week, no 3-M coordinator billet was provided. In conflict with staffing standards published by NAVMMAC, 3-M coordinator was assigned as a collateral duty.
- No ship's force billets were identified for ASW helicopter support, work which by Navy standards normally requires two or three SN billets. (Only one SN was provided for helicopter evolutions; all FM for the hangar space was allocated to aviation detachment.)

Commanding Officer Evaluation

A month earlier, April 1976, the commanding officer (CO) of the DD-963 submitted his evaluation of ship manning following 26 weeks of Phase I post-delivery testing (message to CNO, 30 April 1976). This message provided justification for the CO's recommendation that 29 billets (5 OS, 1 RM, 3 GMG, 8 EN, 2 IC and 10 SN) be added to the PSMD, excluding any additional manning requirements for the equipments to be installed during SCN RAV (NATO SEA SPARROW, LAMPS Mk I, EW suite, RBOC, NIXIE, LINK 14 MOD) or Fleet Modernization Program (FMP) RAV (NTDS AN/UYA-4 MODS, AN/WSC-3, NAVMACS A PLUS, AN/SRR-1, and HARPOON (deferred)). Justification was based on a daily manhour accounting log kept on each crew member from ship commissioning (20 September 1975) through completion of final contract trials (22 March 1976). It showed the following:

- Watchstations. Need for eight additional watchstations including three combat information central (one supervisor, two R/T net talkers), two additional stations for radio control, and three in the engineering spaces (one each in the two main engine rooms, and one in auxiliary machine room #1). Justification for the latter included four incidents where the CO's caution in manning these spaces had paid off by preventing a fire from becoming severe and preventing flooding.

- PM/CM. Overall PM required was 11 hours/week less than provided by PSMD, but CM was 640 hours/week more (at sea). While a portion of the excess CM was ascribed to installation deficiencies (especially for the STG rating), the CO pointed out that CM for many equipments obviously had been underestimated: Mk 45 guns and ammunition strike down elevators (PM underestimated as well) (GMG rating); waste heat boilers, air compressors, generators and salt water pumps (EN rating); evaporators and sewage treatment plant (EN rating); 60/400 Hz converters, GMT fans, generator controls (EN rating); control system consoles, alarm and indicator system (IC rating); and HT repair work (129 hours/ week required versus 5 hours/week provided in PSMD).
- FM. FM requirements were 1,335 hours/week (at sea) more than the 1,500 provided in the PSMD: "Facilities maintenance requirements have been grossly underestimated in the PSMD."
- OUS. OUS requirements were 2,391 hours/week (at sea) more than the 2,230 provided in the PSMD. The CO pointed out that while the UT workload should diminish from the level experienced during testing, the clerical workload in the YN, PN, DK, and SK ratings was double the time provided in the PSMD.

Document #2

This document was an official OP-124E-approved revision to the 30 June 1975 PSMD. The revision, entitled "Interim Change One," was issued September 1976. It was drafted by the SHAPM following an early August meeting with OP-01 and OP-03. The document was approved by OP-124E, who also directed that the manning impact of new equipments (to be installed during SCN RAV and FMP RAV), as identified by the SHAPM, be included in this revision. (The difference between the two types of RAV is one of funding and responsibility: the former is under SHAPM management using program funds, while the latter is under SLM management using other funds.)

As background, the fire which occurred on the DD-963 in February had been investigated by NAVSEC at the request of SHAPM. The fire and failure of the alarm system were attributed to poor workmanship by the builder and lack of quality control (fuel gauge not working, check valves installed the wrong way, camera installed wrong, etc.). While we have not seen the source documents, we were told that a formal NAVSEC position paper, endorsed by the

SHAPM, stated that hardware fixes combined with a roving patrol (as provided in the PSMD) would alleviate the need for watchstations in the engineering spaces requested by the CO; and that these spaces were not designed to be manned (noise in excess of 90 dB; temperature close to 100° F). In the meeting referred to above, it was decided not to man those spaces pending further experience.

The PSMD change added 29 billets to ship manning requirements as follows:

- 14 billets associated with new equipment:
 - 3 EW for AN/WLR-1 and -11 (including 1 Condition III watchstation)
 - 7 FT and 2 GMM for NATO SEA SPARROW (including 2 Condition III watchstations)
 - 2 STG for AN/SQR-17 (LAMPS shipboard acoustic processor)
- 15 billets to correct existing deficiencies:
 - 1 RM required to add 2 additional watchstations in radio control (NEC changes for 2 RMs were required for NAVMACS A Plus to be installed during RAV)
 - 3 OS for additional supervisor watchstation in CIC (manning for additional talker station was compensated by eliminating the need for Condition III manning of the anti-submarine air control (ASAC) station).
 - 11 SN for 1 additional watchstation on the bridge (3), for LAMPS support (3), and for deck force workload (5) estimated at 200 additional hours of FM and 50 additional hours of PM/CM.

This change thus granted 14 of the 29 billets recommended by the CO. A comparison of the watchstations is shown in Table 2-3.

Document #3

In November 1977, over two years after the ship was commissioned, NAVMACLANT published the results of its manning validation for the DD-963, conducted through a shipboard survey while inport. Using standard procedures

TABLE 2-3. ENLISTED WATCHSTATIONS (CONDITION III)

	PSMU May 76	Δ (CNU)	Rev. #1 Sep. 76	Δ (NAV/MAC/IAINT)	SMU Nov. 77	Δ (CNU)	SMU Aug. 78
<u>Ship Control</u>							
- Pilothouse/Bridge	4	add 1 talker (JL)	5	eliminate talker, add messenger	5	add 1 talker (JL)	6
- Lookouts	3		3		3		3
<u>Ops. Control</u>							
- CIC	2	eliminate ASAC sta., add CIC supervisor, add R/T talker	3		3	add computer console operator	4
- Surface/Subsurface	3		3	reassign stations	3		3
- Detection and Tracking	4		4	eliminate computer monitor, reassign sta.	3	delete computer console operator	2
- EW	-	add 1 ESM operator	1	add 1 EW supervisor	2		2
<u>Comm. Control</u>							
- Radio Control	2	add supervisor, add standby FAC	4	rename stations	4		4
- Signal Bridge	2		2		2		2
<u>Weapons Control</u>							
- Control Center	0	add FC radar operator, add firing console operator for SEA SPARRROW	2		2		2
- Gun Control	1		1		1		1
- Mount 51 Magazine	1		1		1		1
<u>ASN Control</u>							
- Sonar Control	4		4		4		4
- LCSS	0		0	add ASROC launcher capt., assistant launcher, add sentry	3	add ASROC roving patrol	4
<u>Engineering Control</u>							
- CSS	4		4		4		4
- Engine Rooms	-		-		-	add station in Engine Room #1 and #2	2 ^a
- Aux. Mach. Rooms	-		-	add aux. equip. operator	1		1
- IC Rooms	-		-	add IC switchboard operator	1		1
<u>Damage Control</u>							
- DC Central	3		3	combine forward and aft security watch	2	split sounding and security watch into fore and aft stations	3
TOTAL	33		40		44		49

^a Actual fleet practice is to have 2 men per main engine room in Condition IV though not required by TYCOM.

(OPNAV 12P4), the survey team validated the MIPs, counted the number of identical equipments associated with each MIP; took PM requirements from the MIPs, with CM workload estimated on the basis of PM:CM ratios; measured FM and OUS workloads through activity sampling supplemented with interviews of supervisors; and assessed watchstation requirements. The resulting raw data were entered into the Navy Manpower Requirements System (NMRS). This system essentially automates the SMD process in accordance with 10P-23 (it is described in a previous LMI report, Betaque, et al, August 1978). The resulting draft SMD was submitted for OP-01 approval.

This document introduced a change in shipboard organization (see Figure 2-2), added several watchstations (see Table 2-3), and added six billets to the PSMD Change #1. (In the meantime, the HARPOON missile system had been installed). Unfortunately, there were some inconsistencies in this document. Appendix D (Summary of Weekly PM Requirements) identified a total PM workload of 1,346 hours/week, while Appendices E (Ship Manpower Requirements Analysis Chart) and H (Workload Summary) identified a PM workload of 993 hours/week (at sea) (including MR/PA allowance). Table 2-4 shows a breakout of the PM/CM estimates by division and compares the figures with Litton's estimates (reconstructed to agree with the revised shipboard organization) and the approved SMD discussed next.

Document #4

An SMD conference held in January 1978 to review NAVMMACLAN's draft SMD left three issues unresolved:

- (1) Manning of engineering spaces at Condition III
- (2) Provision of reload capability for the chaff launcher (RBOC) at Condition III
- (3) Manning of the EW system at Condition III

FIGURE 2-2. SHIPBOARD ORGANIZATION CHANGES

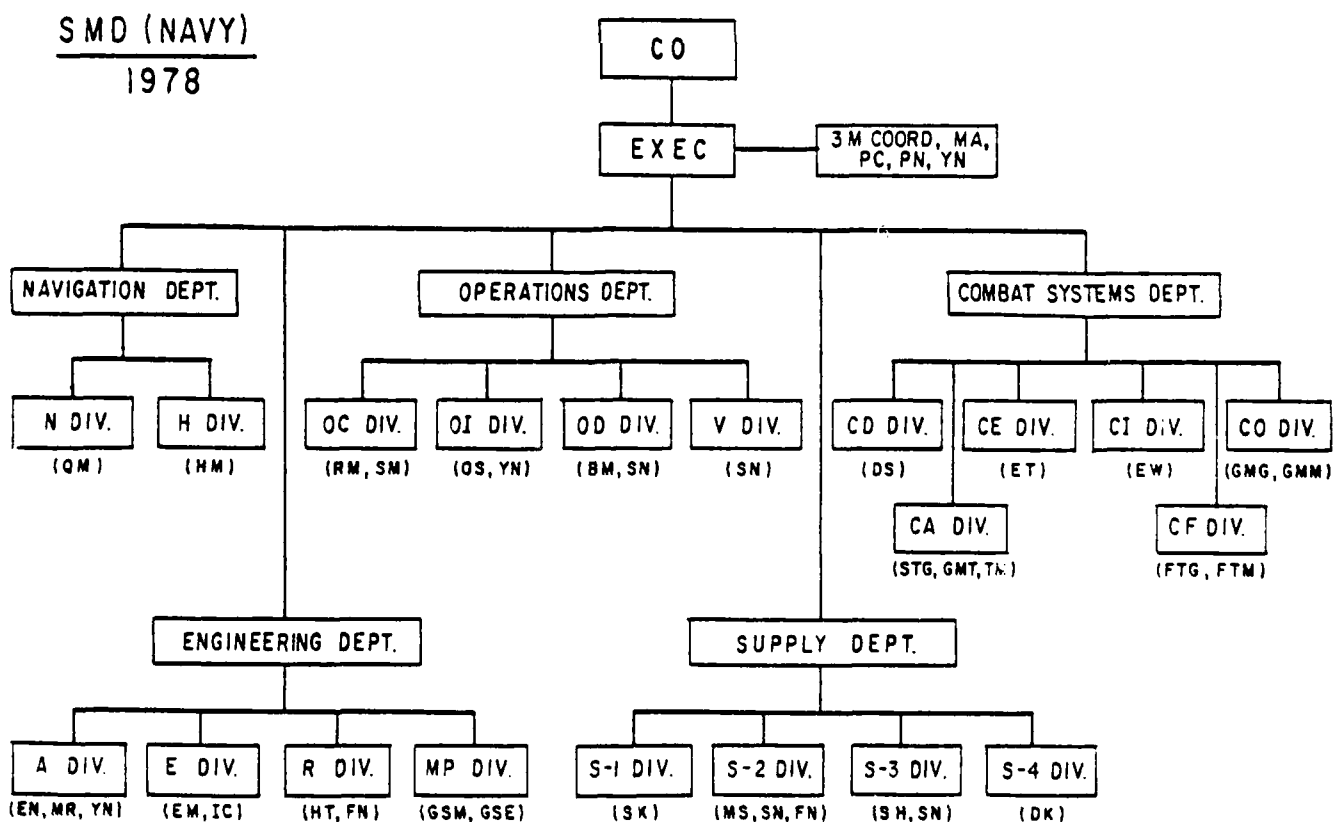
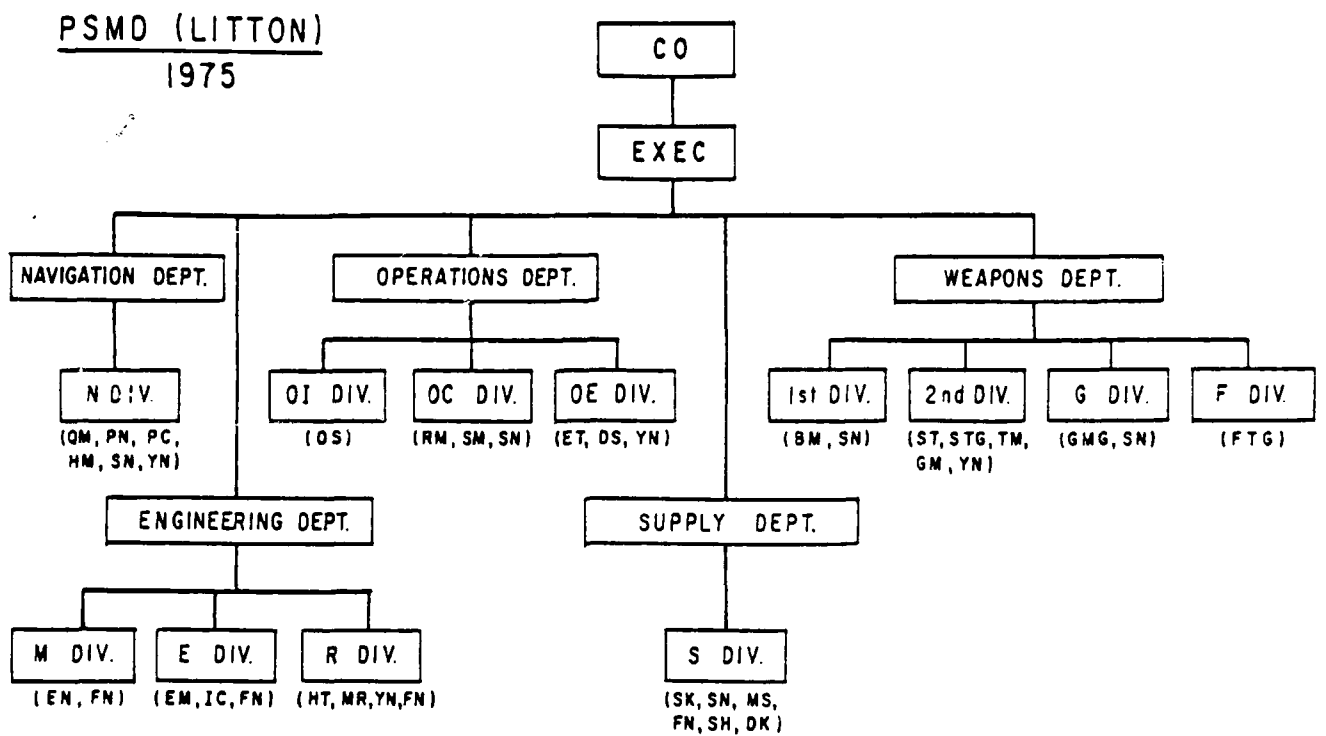


TABLE 2-4. BREAKOUT OF PM/CM ESTIMATES (MAN-HOURS/WEEK, AT SEA)^a

DIVISION ^b	RATING	SOURCE DOCUMENT						
		Litton PSMD May 76 ^c		NAVMAC/LANT Draft SMD ^d Nov. 77			CNO Class SMD Aug. 78	
		PM	CM	PM	PM	CM	PM	CM
X		0	0	15.0	11.3	0	19.5	0
N	QM	5.9	0.2	8.9	6.5	2.2	11.6	3.4
H	HM	2.0	0	5.9	4.4	0	7.8	0
OC	RM/SM	60.1	25.1	37.7	27.5	2.0	49.2	3.7
OI	OS	17.2	0	25.6	28.8	0	33.5	0
OD	BM	52.8	0.2	100.0	74.5	21.0	123.2	34.5
CD	DS	48.6	40.1	21.9	16.3	9.8	28.6	24.9
CE	ET	122.7	112.8	38.9	29.0	33.6	50.8	51.9
CI	EW	0	0	11.3	8.3	5.8	14.8	10.3
CO	GMM/GMG	67.8	28.5	137.5	97.6	30.8	179.2	58.9
CF	FT	15.8	2.4	65.5	48.3	15.6	85.5	27.7
CA	STG/GMT/TM	171.8	25.8	199.0	147.2	4.8	236.2	81.8
A	EN	162.8	20.2	132.9	98.4	34.2	169.5	59.8
E	EM/IC	167.6	64.0	172.7	128.0	48.6	198.2	76.5
R	HT/MR	138.4	5.1	129.4	95.9	101.0	168.5	175.6
MP	EN (GSM/GSE)	137.8	39.6	189.3	140.1	49.8	277.9	99.8
S-1	SK	3.7	0	9.0	6.6	0	0	0
S-2	MS	0	0	40.2	29.9	0	0	0
S-3	SH	0.6	0	4.8	3.5	0.2	6.3	0
S-4	DK	6.3	0	0.6	0.4	0	0.9	0
SHIP TOTAL		1,182	364	1,346	993	397	1,725	710

^aAll PM figures include MR/PA allowance.

^bV division has, by policy, no PM/CM workload assigned to ship's force.

^cEstimates reconstructed on the basis of ratings to agree with SMD organization.

^dFirst column shows PM data from Appendix D. Other two columns show data from Appendix E.

With respect to the engineering spaces, the position of the SHAPM was that from a technical standpoint, they did not require manning, in view of the improvements made to the hardware, software and procedures, ensuring proper operation of the equipment installed in the unmanned spaces, as well as the remote sensing devices designed to indicate an abnormal condition or malfunction. The position of the Fleet Commanders was that these spaces should be manned in Condition III, based on "present shipboard practice and experience to date with systems reliability" and as a precautionary measure. The position of OP-03, while recognizing the manpower-saving intent of the equipment design, was supportive of the Fleet Commanders: "the concerns for ship and equipment safety voiced by operational commanders cannot be ignored."

With respect to the chaff launcher (RBOC), conference participants expressed a need to provide a reloading capability during all underway watch conditions, not just Condition I as provided in the draft SMD. The SHAPM's position, however, was that no Condition III watch requirements had been identified for reload of the launchers, and OP-03 agreed on the basis that the recently approved NTP for the RBOC did not identify Condition III launcher stations. (The NTP identified three Conditions III watchstations: one at the CIC control panel, and one each at the starboard and port bridge control panels. The draft SMD was in accordance with the RBOC NTP).

With respect to EW Condition III watchstations, the fleet desired a second operator position (in addition to the operator and supervisor stations provided in the draft SMD) to provide simultaneous coverage of the WLR-1, WLR-11, and EW Supervisor/NTDS Operator consoles. The SHAPM's position was that this would blur the distinction between Conditions I and III, and that the draft SMD was in accordance with the watchstations aboard other ships possessing WLR-1/WLR-11 installations. OP-03 agreed.

OP-03 communicated its position on the above issues to OP-01 in June 1978, and indicated that the ship's ROC/POE would be changed to reflect the need for the additional engineering watchstations.

The approved SMD for the DD-963 class was published 30 August 1978. This document added another 17 billets to PSMD Interim Change #1, resulting in a total of 270 enlisted billets for the ship's force. Added watchstations (see preceding Table 2-3) included the previously unmanned engineering spaces as recommended by OP-03 as well as by OPTEVFOR (operational evaluation of DD-963 mobility, March 1977) and INSURV. (The recommendations of the latter were conditional, i.e. pending achievement of a reliable automatic alarm system.)

Recognizing that increases in ship manning requirements by this time had used up the accommodation growth margin (leaving no bunks available for an antisubmarine warfare helicopter detachment), it would seem that the class SMD was constrained by the available bunks. FM and CM requirements were known to be much larger than those identified in the SMD.

- The FM workload was 100 hours/week less than the original Litton estimate which, according to all reports, was a gross underestimate of the actual work involved to keep the ship at minimum acceptable standards. All INSURV reports had noted FM deficiencies. The CO had suggested that 1300 hours/week more were required.
- The growth in PM requirements since September 1976, without equipment additions, suggests a significant lag in the updating of the Planned Maintenance System (PMS) (MIP/MRC) (1976: 1,210; 1977: 1,345 (erroneously reported as 990); 1978: 1,725 man-hours/week). On the one hand, it shows that the PMS feedback system is working. On the other hand, with a trend like this (50 percent growth in 2 years) one could anticipate further growth until PMS workload stabilized. But an allowance for such future growth in the appropriate ratings is not provided in the SMD process. Also, INSURV reports showed that these ships manned at MPA (247 enlisted) could not keep up with the PMS workload. The average PMS performance was 68 percent, well below the CNO goal of 75 percent (OPNAV Instruction 4790.8) and fleet average (close to 80 percent).

Table 2-5 shows the manpower requirements stated in the SMD by rating, and compare these numbers with the PSMD figures, as well as the current MPA.

Document #5

Two years after commissioning of the DD-964 (USS FOSTER), it was the turn of NAVMACPAC to conduct its validation of ship manning requirements. Using the same procedures as NAVMACLANT, it arrived at a manning estimate of 312 enlisted (the number of officers did not change throughout the program) vice NAVMACLANT's figure of 253 for the DD-963 (revised by CNO to 270 in the approved SMD). Both ships are the same configuration and were built by the same shipbuilder at the same shipyard under similar circumstances (i.e., rushed to delivery to avoid penalties, manufactured by an as yet relatively inexperienced labor force, and with little hands-on quality control by the Navy).¹ The NAVMACPAC document, submitted to OP-01 in May 1979, showed a growth of 30 percent in OUS, 40 percent in FM, and over 40 percent in PM and CM workloads compared to the Class SMD approved eight months earlier. No explanation for the PM growth was available other than that it was based on documented maintenance requirements (MIP/ MRCs). One major change was that the PMS included a new standard for valve maintenance which was not available at the time NAVMACLANT conducted its survey; this explained several hundred hours of the 700 hours difference in PM workload. The increases in FM and OUS were presumably due to not limiting the analysis to activity sampling (measuring what is actually done vice what should be done) but supplementing these

¹The new quality specification invoked by the DD-963 (and LHA) contract (MIL-Q-9858-A) emphasized auditing the contractor's inspection procedures vice conducting hands-on inspections as done in the past. The theory was that if QA/QC procedures were adequate and approved, the system would produce a quality product.

TABLE 2-5. DD-963 (USS SPRUANCE) ENLISTED MANPOWER REQUIREMENTS

Department	Div.	Rating	Final ¹ PSMD 22 May 76	Δ	Interim Change #1 10 Sep 76	Δ	SMD 30 Aug 78	Δ	MPA 26 Mar 80
Executive	X	EM	1	-	1	-	1	-	1
		MA	1	-	1	-	1	-	1
		PC	1	-	1	-	1	-	1
		PN	2	-	2	-	2	-	2
		YN	2	-	2	-	2	-	2
		NC	-	-	-	-	-	+1	1
Dept. Subtotal			7	-	7	-	7	+1	8
Navigation	N	QM	5	-	5	-	5	-	5
	H	HM	2	-	2	-	2	-	2
Dept. Subtotal			7	-	7	-	7	-	7
Operations	OC	RM	12	+1	13	-	13	-	13
		SM	4	-	4	+2	6	-	6
	OI	SN	2	-	2	-2	-	-	-
		OS	16	+3	19	+3	22	-	22
	OD	YN	-	-	-	+1	1	-	1
		BM	7	-	7	+7	14	-	14
	V	SN	21	+11	32	-6	26	-	26
		SN	-	-	-	+2	2	-	2
Dept. Subtotal			62	+15	77	+7	84	-	84
Combat Systems	CD	DS	7	-	7	-	7	-	7
		YN	1	-	1	-1	-	-	-
	CE	ET	11	-	11	-	11	-	11
		CI	EW	-	+3	3	+3	6	-
	CO	GM	6	+2	8	+1	9	-	9
		SN	2	-	2	-1	1	-	1
	CF	YN	-	-	-	+1	1	-	1
		FT	6	+7	13	-1	12	-	12
	CA	ST	15	+2	17	+1	18	-	18
		GM	4	-	4	+6	3	-	4
	EM	YN	1	-	1	-1	2	-	2
		YN	1	-	1	-1	-	-	-
Dept. Subtotal			54	+14	68	+7	75	-4	71
Engineering	A	EN	19	-	19	-12	7	-	-
		YN	-	-	-	+1	1	-	1
		FN	8	-	8	-7	-	-	5
		MR	-	-	-	+1	1	-	1
	E	EM	10	-	10	-4	6	-	6
		IC	5	-	5	-	5	-	5
		FN	1	-	1	-1	-	-	-
	R	HT	7	-	7	+3	10	-	10
		FN	3	-	3	-	3	-	3
		MR	1	-	1	-1	-	-	-
	MP	YN	1	-	1	-1	-	-	-
		GS	-	-	-	+27	27	-	27
		FN	-	-	-	+4	4	-	4
Dept. Subtotal			55	-	55	+10	65	+4	69
Supply	S-1	SK	6	-	6	-1	5	-	5
		SN	1	-	1	-1	-	-	-
	S-2	MS	-	-	-	+11	11	-	11
		CS	3	-	3	-8	-	-	-
		SD	6	-	6	-6	-	-	-
		FN	3	-	3	-1	2	-	2
	S-3	SN	7	-	7	-1	6	-	6
		SH	6	-	6	-1	5	-	5
		SN	1	-	1	-	1	-	1
	S-4	DK	1	-	1	+1	2	-	2
Dept. Subtotal			39	-	39	-7	32	-	32
TOTAL			224	+29	253	+17	270	+1	271

The shipboard organization assumed in the PSMD differed from that in the SMD of August 1978 (see Figure 1-2). The two preceding documents have been constructed to agree with the latter's organizational structure for comparison purposes.

data with experience on similar ships and supervisor interviews. No changes in watchstations were identified. (Due to different operational use, the OUS workload for Pacific Fleet ships normally exceeds that for Atlantic Fleet ships).

This draft SMD for the DD-964 caused an uproar at OPNAV. NAVMMACLANC was directed to review it, and NAVMMACPAC was directed to reduce its estimate.

Document #6

This document, delivered two weeks later, reflects adjustments by NAVMMACLANC of NAVMMACPAC's draft SMD. A total of 18 billets were shaved off NAVMMACPAC's estimate, reducing FM and OUS workloads by 700 hours, PM by 200 hours, and CM by 150 hours. (Compared with NAVMMACLANC's earlier validation effort, the resulting document still showed an increase of 41 billets). The document was re-submitted to OP-01.

Document #7

After several iterations, NAVMMACPAC had resubmitted a draft showing 301 enlisted billets, reducing some of its previously estimated workloads. Told by OPNAV that 300 was the uppermost acceptable ceiling on its "validated" manning requirement, NAVMMACPAC eliminated 2 additional billets, arriving at a requirement of 299 enlisted. This draft SMD was submitted in July 1979.

Document #8

A revised draft SMD for the class has been circulated within OPNAV since 31 July 1979. The document was not made available for LMI review but, reportedly, it identifies an enlisted requirement of 295 billets as shown in Table 2-2. This draft has not been approved and may not be until the ships come out of their first overhauls (including installation of 45 additional

enlisted bunks). At that time, the class SMD will be superceded by hull-specific SMDs.

Future Growth

Data point 9 in Figure 2-1 represents an informal estimate from OP-112 of the effect of planned configuration changes (see Table 1-2). The estimate uses 295 as the baseline estimate for the current configuration of the ship. However, the point estimate of 302 enlisted personnel does not include 12 billets required for operating and maintaining OUTBOARD, intelligence equipment being installed on some ships of the DD-963 class. The SHIPALTs to be installed during first overhaul will add 45 enlisted bunks to the berthing accommodation, so that it would appear that the new configuration will be able to accommodate the required ship's force and LAMPS detachment without affecting habitability standards (except for those ships of the class equipped with OUTBOARD). As indicated earlier, further configuration changes may be anticipated for the future. Historically, the hull life of a ship is approximately 30 years, while the weapon suite is modernized every 10 years. The DD-963 is planned for a 5-year overhaul cycle. The DD-963 has significant space and weight margin for equipment growth. The ship (in its current configuration as it goes into overhaul) can tolerate growth of about 850 tons before affecting any of its performance characteristics; 210 tons are reserved for specific future growth; 90 tons for unspecified future growth; 550 tons for unidentified service life growth.

MANPOWER AUTHORIZATION CHANGES

The manpower authorizations (MPA) programmed for the DD-964 are shown in Table 2-6. The MPA for the DD-963 are the same, except for the addition of one career counselor billet in the Executive Division (DD-963 OPNAV 1000/2 dated 26 March 1980). The basic allowance (BA) files maintained at TYCOM,

reviewed prior to October 1980, did not show the addition of 12 enlisted billets authorized as of 1 October 1980 for operation and maintenance of OUTBOARD. This increase is in addition to the baseline (unapproved) SMD of 295 enlisted. Table 2-6 shows that the MPA was below ship manning requirements throughout the first operating cycle of the ship, lagging SMD updates by about one and a half years. (This experience of the DD-964 contradicts the popularly held belief that MPA are more responsive than SMD to changing manpower needs.)

TABLE 2-6. SHIP MANPOWER AUTHORIZATIONS (DD-964)

OPNAV 1000/2	Billets Authorized	Requirements								
		FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85
02/04/77	243	243	243	243	256	256	256			
09/08/77	242	242	246	246	261	261	261			
09/27/78	247		247	247	281	281	281	281		
10/16/78	247			247	281	281	281	281	281	
03/06/79	247			247	282	282	282	282	282	
07/26/79	247			247	282	282	282	282	282	
03/21/80	282*				282	286	286	286	286	286

*This total includes 270 for the ship in its present configuration plus 12 enlisted for new equipment (OUTBOARD) with effective date October 1980.

Table 2-7 shows that by rate/rating, the present authorizations are very close to the approved Class SMD; the only difference consists of four fewer GMTs (in paygrades E-4 and E-5, which are short), four more FNs, and one EM CPO, for a total authorization of 271 (DD-963).

PERSONNEL CHANGES

This section addresses the extent to which the Navy has been able to

TABLE 2-7. COMPARISON OF ENLISTED PERSONNEL ONBOARD DD-963 AND AUTHORIZED MANPOWER BY RATE AND RATING

RATING TITLE	RATING	RATE	SHD AUG 78	BA	NMP	COB
Boatswain's Mate	BM	C	1	1	1	1
	BM	1	1	1	1	2
	BM	2	2	2	2	4
	BM	3	3	3	4	4
	BM	SN	7	7	3	3
	BM	Total	14	14	11	12
Disbursing Clerk	DK	C	0	0	0	0
	DK	1	1	1	1	1
	DK	2	0	0	0	0
	DK	3	0	0	0	0
	DK	SN	1	1	1	1
	DK	Total	2	2	2	2
Data Systems Technician	DS	C	1	1	1	2
	DS	1	1	1	0	0
	DS	2	3	3	2	4
	DS	3	2	2	3	1
	DS	SN	0	0	0	0
	DS	Total	7	7	6	7
Electrician's Mate	EM	C	1	2	2	2
	EM	1	1	1	1	1
	EM	2	1	1	0	0
	EM	3	2	2	2	2
	EM	FN	1	1	2	2
	EM	Total	6	7	7	7
Engineman	EN	C	0	0	0	0
	EN	1	1	1	1	1
	EN	2	1	1	0	3
	EN	3	4	4	2	2
	EN	FN	1	1	11	7
	EN	Total	7	7	14	13
Electronics Technician	ET	C	1	1	1	1
	ET	1	1	1	1	0
	ET	2	5	5	4	5
	ET	3	4	4	5	6
	ET	SN	0	0	1	0
	ET	Total	11	11	12	12
Electronics Warfare Technician	EW	C	1	1	0	0
	EW	1	1	1	1	1
	EW	2	2	2	2	2
	EW	3	1	1	2	1
	EW	SN	1	1	0	0
	EW	Total	6	6	5	4
Fireman	FN	C	10	14	11	14
	FN	1	10	14	11	14
	FN	2	10	14	11	14
	FN	3	10	14	11	14
	FN	SN	0	0	0	0
	FN	Total	5	5	5	7
Fire Control Technician (Gun Fire Control)	FTC	C	1	1	1	1
	FTC	1	0	0	0	1
	FTC	2	1	1	1	4
	FTC	3	3	3	2	0
	FTC	SN	0	0	1	1
	FTC	Total	5	5	5	7
Fire Control Technician (Missile Fire Control)	FTM	C	0	0	0	0
	FTM	1	1	1	1	1
	FTM	2	3	3	3	5
	FTM	3	0	0	0	1
	FTM	SN	3	3	3	2
	FTM	Total	7	7	7	9
Gunner's Mate (Guns)	GMG	C	0	0	0	0
	GMG	1	1	1	1	2
	GMG	2	4	4	2	4
	GMG	3	1	1	2	4
	GMG	SN	1	1	2	1
	GMG	Total	7	7	7	11
Gunner's Mate (Missiles)	GMH	C	0	0	0	0
	GMH	1	1	1	0	0
	GMH	2	0	0	1	1
	GMH	3	1	1	0	1
	GMH	SN	0	0	1	0
	GMH	Total	2	2	2	2
Gunner's Mate (Torpedos)	GHT	C	0	0	1	0
	GHT	1	1	1	0	0
	GHT	2	3	1	1	2
	GHT	3	3	1	0	1
	GHT	SN	1	1	1	1
	GHT	Total	8	4	3	4
Gas Turbine System Technician	GS	C	1	1	1	1
	GS	1	0	0	0	0
	GS	2	0	0	0	0
	GS	3	0	0	0	0
	GS	FN	0	0	0	0
	GS	Total	1	1	1	1
Gas Turbine Systems Technician (Electrical)	GSE	C	1	1	1	1
	GSE	1	1	1	0	1
	GSE	2	1	1	2	5
	GSE	3	4	4	2	0
	GSE	FN	0	0	1	0
	GSE	Total	7	7	6	7
Gas Turbine Systems Technician (Mechanical)	GSM	C	1	1	1	2
	GSM	1	2	2	2	2
	GSM	2	6	6	2	5
	GSM	3	10	10	4	2
	GSM	FN	0	0	3	2
	GSM	Total	19	19	12	13
Hospital Corpsman	HM	C	1	1	1	1
	HM	1	0	0	0	0
	HM	2	0	0	0	1
	HM	3	1	1	1	0
	HM	SN	0	0	0	0
	HM	Total	2	2	2	2
Hull Maintenance Technician	HT	C	1	1	1	1
	HT	1	2	2	1	1
	HT	2	2	2	3	3
	HT	3	4	4	2	5
	HT	FN	1	1	5	3
	HT	Total	10	10	12	13

TABLE 2-7. COMPARISON OF ENLISTED PERSONNEL ONBOARD DD-963 AND AUTHORIZED MANPOWER BY RATE AND RATING
(Continued)

RATING TITLE	RATING	RATE	SHD AUG 78	BA	NHP	COB
Interior Communications Technician	IC	C	0	0	0	0
	IC	1	1	1	1	1
	IC	2	1	1	1	1
	IC	3	2	2	1	2
	IC	FN	1	1	1	1
	IC	Total	5	5	4	5
Master- At-	MA	C	1	1	0	0
	MA	1	0	0	1	1
	MA	2	0	0	0	0
	MA	Total	1	1	1	1
Machinery Repairman	MR	C	0	0	0	0
	MR	1	0	0	0	0
	MR	2	1	1	0	1
	MR	3	0	0	1	0
	MR	FN	0	0	0	0
	MR	Total	1	1	1	1
Mess Management Specialist	MS	C	1	1	1	1
	MS	1	2	2	2	2
	MS	2	2	2	2	2
	MS	3	3	3	2	3
	MS	SN	3	3	3	2
	MS	Total	11	11	10	10
Navy Counselor	NC	C	0	0	0	0
	NC	1	1	1	1	1
	NC	2	0	0	0	0
	NC	3	0	0	0	0
	NC	SN	0	0	0	0
	NC	Total	0	1	1	0
Operation Specialist	OS	C	1	1	0	1
	OS	1	3	3	2	3
	OS	2	4	4	3	3
	OS	3	8	8	4	5
	OS	SN	6	6	8	6
	OS	Total	22	22	17	16
Postal Clerk	PC	C	0	0	0	0
	PC	1	0	0	0	1
	PC	2	0	0	0	0
	PC	3	1	1	1	0
	PC	SN	0	0	0	0
	PC	Total	1	1	1	1
Personnelman	PN	C	0	0	0	0
	PN	1	1	1	1	1
	PN	2	0	0	0	0
	PN	3	1	1	1	0
	PN	SN	0	0	0	0
	PN	Total	2	2	2	2
Quartermaster	QM	C	0	0	0	0
	QM	1	1	1	1	1
	QM	2	1	1	1	1
	QM	3	2	2	1	2
	QM	SN	1	1	2	2
	QM	Total	5	5	5	6

RATING TITLE	RATING	RATE	SHD AUG 78	BA	NHP	COB
Radioman	RM	C	1	1	0	1
	RM	1	2	2	2	2
	RM	2	2	2	2	3
	RM	3	5	5	3	4
	RM	SN	3	3	6	4
	RM	Total	13	13	13	14
Ship's Serviceman	SH	C	0	0	0	0
	SH	1	1	1	1	0
	SH	2	1	1	1	1
	SH	3	2	2	1	3
	SH	SN	1	1	2	0
	SH	Total	5	5	5	4
Storekeeper	SK	C	1	1	1	1
	SK	1	1	1	1	0
	SK	2	1	1	1	1
	SK	3	1	1	0	3
	SK	SN	1	1	2	0
	SK	Total	5	5	5	5
Signalman	SM	C	0	0	0	0
	SM	1	1	1	1	1
	SM	2	1	1	2	0
	SM	3	2	2	1	2
	SM	SN	2	2	2	2
	SM	Total	6	6	5	5
Seaman	SN	SN	36	36	29	29
	SN	Total	36	36	29	29
Sonar Technician (Surface)	STG	C	1	1	1	1
	STG	1	3	3	1	2
	STG	2	4	4	5	7
	STG	3	5	5	5	5
	STG	SN	5	5	6	3
	STG	Total	18	18	18	18
Torpedoman	TM	C	0	0	0	0
	TM	1	0	0	0	0
	TM	2	1	1	0	2
	TM	3	1	1	1	0
	TM	SN	0	0	1	1
	TM	Total	2	2	2	3
Yeoman	YN	C	0	0	0	1
	YN	1	1	1	1	0
	YN	2	0	0	0	1
	YN	3	1	1	1	0
	YN	SN	3	3	2	1
	YN	Total	5	5	4	1

satisfy the DD-963 manpower authorizations by assigning personnel with the appropriate skills and skill levels. Our approach is to compare the authorized manpower, or basic allowance (BA), to the Navy Manning Plan (NMP) and current on-board (COB) personnel for the DD-963. The NMP is a computer program which aggregates authorized manpower requirements, compares this to the aggregate inventory and computes a ship's fair share of available resources. The COB reflects personnel actually assigned to the ship. Table 2-7 compares the DD-963 SMD (August 1978), BA (March 1980), and COB (June 1980) by rating (career field) and rate (skill level): "C", an aggregation of chief petty officer, senior chief petty officer, and master chief petty officer, designates the highest skill level (or pay grade) and SN/FN the lowest. These data reflect what was current as of June 1980; they pertain to a replacement crew, not the original commissioning crew. Historical data were not available for the NMP and COB.

In most ratings, DD-963 manning is close to authorized billets. The largest shortages occur in the GSM (6), OS (6), and SN (7) ratings. The largest overages are in the EN (6), and GMG (4) ratings.

Table 2-8 summarizes the same information by paygrade. The DD-963 has shortages of E-4s (17) and E-6s (7). However, it has a surplus of E-5s (21).

TABLE 2-8. SUMMARY OF ENLISTED PERSONNEL ONBOARD DD-963
AND AUTHORIZED MANPOWER BY PAY GRADE

PAY GRADE	BA	NMP	COB	SMD
E-9	1	1	0	1
E-8	3	1	4	3
E-7	14	13	15	14
E-6	34	26	27	33
E-5	51	43	72	53
E-4	75	53	58	77
E-3	93	111	87	89
TOTAL	271	248	263	270

Overall, the DD-963 is reasonably well supplied with personnel in the appropriate pay grades and ratings.

Table 2-9 shows the fill of authorized billets in selected NECs. The most serious shortages seem to be with the auxiliary system technicians, where the skill (NEC 4398) is not onboard, and the gas turbine system technicians, where the onboard skills (NEC 4112) are substantially short of authorization. Both NECs are unique to the DD-963 class, and Navy training was implemented only recently (fiscal 1979).

TRAINING REQUIREMENTS CHANGES

Training requirements for the DD-963 ships's force (as well as intermediate maintenance activity personnel) are documented in the NTP for the class (NTP-S-71-28). The first NTP was submitted by Litton in November 1970 and reviewed in an NTP conference held January 1971. Subsequent updates through May 1975 showed little change.

In addition to the NTP, Litton submitted separate Crew Scheduling and Phasing Plans (CSPP) as contract deliverables. (The CSPP specifies the training pipeline and schedule for each billet, whereas the NTP is system- and training course-oriented. A CSPP is normally published as an annex to the NTP). The first seven CSPPs issued from August 1971 through September 1974 were not hull-specific, but provided a "master training schedule" for the DD-963 class. The final five CSPPs pertained to specific sets of hulls. The final issue (dated April 1979 and pertaining to ships 26 through 30) was the first CSPP based on the CNO-approved SMD of August 1978. Because Navy take-over of contractor courses was completed by the end of fiscal 1976, Litton disclaimed responsibility for the training course data in the last four CSPPs.

TABLE 2-9. AUTHORIZED MANPOWER AND CURRENT ONBOARD PERSONNEL COMPARISON
FOR SELECTED NECs (DD-963 ONLY)

UNIQUE PIPELINE/ EQUIPMENT	NEC RATING	TITLE	BA	COB
DD-963 Unique Training Pipelines	ET-1454	DD-963 Communication Technician	2	1
	DS-1672	DD-963 Class Computer/Peripheral Technician	3	2
	DS-1682	DD-963 Class Display Equipment Equipment Maintenance Technician	2	2
	GS-4111	Gas Turbine Mechanical Maintenance Technician	12	11*
	GS-4112	DD-963 Class Electrical Equipment Technician	7	4
	GS-4115	Gas Turbine Controls Maintenance Technician	2	3
	EN-4398	DD-963 Auxiliary Systems Technician	2	0
	EM-4626	DD-963 Electrical Component Maintenance Technician	0**	0
ASROC Weapons Handling System	GMT-0841	ASROC Launching Group Mk 16 Maintenceman	4	3
Mk 86 Gunfire Control System	GMT-1125	Automatic Gunfire Control System Technician	4	5
AN/SPS-40B Radar Set	ET-1516	Radar Technician	2	1

* Includes one EN-4111.

**NEC 4626 was first included in the January 1979 NEC Manual update and subsequent CSPP, April 1979. Previously generated OPNAV 1000/2 forms for DD-963 class ships had not been updated accordingly as of June 1980. Only the later ships have this NEC in their BA. Personnel may or may not have received the requisite training prior to NEC creation.

The Navy's review and monitoring of training requirements were focussed on the problems associated with its takeover of training and the changes required for replacement crew training. OP-03 convened a workshop in June 1976 to address these issues. It was decided that the training requirements developed by Litton would not be changed for the commissioning crews, but that some changes would be required after Navy takeover. Recommendations for a replacement pipeline training plan included requirements to create new NECs to properly identify mandatory courses not yet associated with an NEC, and to facilitate the packaging of various short courses. A November 1976 NTP conference, chaired by OP-39, reviewed the recommended replacement training plan. In April 1977, the CNO-approved NTP update was issued, including Annex II which identified replacement crew training requirements.

From 1976 through 1979, a Navy team addressed the problems associated with Navy takeover of contractor courses, delays in ship deliveries, new NECs, class capacity constraints, technical manuals, training equipment and aids. This was the SPRUANCE class training project team (later, training review team), including representatives of OP-39, Chief of Naval Personnel, Fleet Training Commands, and the SHAPM, with CNET/CNTT representatives chairing the meetings.

To identify changes in training requirements, we compared the CSPPs of September 1974 and April 1979. The results are shown in Appendix A. Our analysis did not reveal any substantial changes other than those resulting from introduction of the new gas turbine technician rating (approved by the Rating Review Board in January 1978). However, we did not review the actual course content for each NEC and the curriculum changes which may have occurred.

There is a difference between the approved NTP, which is a requirements document, the implementation of the NTP, which is the training actually given, and the training needed to attain skill proficiency. For example, some of the training courses identified in the NTP may exist only on paper because of insufficient resources (instructors, training materials, training devices), e.g. ASROC weapons handling system maintenance (NEC 0891). Other training courses, while given in accord with the NTP, may be inadequate to prepare trainees for their job requirements. Examples include the AN/SPS-40B operator/maintainer (NEC 1516) and Mk 86 GFCS maintainers (NEC 1125). The next chapters will provide information on how training inadequacies are identified (Chapter 3) and what the precise training problems are for the AN/SPS-40B radar and Mk 86 GFCS--problems which were partially resolved in early 1980 (Chapter 4).

TRAINING EQUIPMENT

A lack of training equipment may constrain or defer implementation of courses identified by the NTP. Authorization and funding of training equipment in the Navy are separated from ship acquisition. Budget constraints may result in deferment of equipment needed to provide hands-on training which, of course, detracts from the quality of training. Importantly, such occurrences cannot be identified by just comparing NTPs or CSPPs.

Apart from budget constraints, changes in training concept may result in unfilled requirements for training equipment. An example of this for the DD-963 class is the "hot plant", a device for system-level training of the propulsion system technicians (NEC 4111, 4112, and 4115, all unique to the DD-963).

The SHAPM did not identify the hot plant as a training equipment requirement. The NTP did identify the training simulators required for the propulsion system technicians (operators as well as maintainers), and these were

funded and installed in 1975 and 1977. However, the need for shore-based system-level training for senior systems technicians (to teach the interfaces between the propulsion subsystems bridging the maintenance responsibilities of three different ratings) was not recognized: it was viewed as a matter of OJT aboard ship. The crews for the first two ships received a propulsion plant familiarization course on the propulsion test bed at Pascagoula. In fiscal 1976 this plant and the combat system land-based test site were refurbished for installation aboard a later ship of the class.

In June 1976, in response to fleet recommendations that hot plant training be introduced for DD-963 class crews, the CNO stated that there would be no such training ashore. CNO noted that DD-965 personnel received training aboard the DD-964 and that the results were highly successful. Subsequent crews would receive hot plant training on their own ships through participation in trials and during the pre-delivery shipboard indoctrination. Regardless, the fleets continued to support the hot plant. At a DD-963 replacement training conference in November 1976, Atlantic and Pacific Fleet representatives reiterated their opinion that to achieve optimum engineering training effectiveness, a hot plant was required and had to be supported. This opinion was supported by OPTEVFOR in its OPEVAL report on DD-963 mobility, issued in March 1977.

With the need for system-level training for senior system technicians recognized, the issue continued with a dispute over the type of training device required: actual equipment (hot plant) or a training simulator. In October 1977, NAVSEA published the results of a study which compared the cost-effectiveness of the two alternatives to provide adequate gas turbine technician training. This study suggested that less than 30 percent of the

necessary skills could be adequately taught with a simulator facility, indicating the need for a hot plant.

This finding was challenged in a Defense Audit Service (DAS) report published in September 1979. DAS had tasked the Naval Training Equipment Center (NTEC) with a cursory evaluation of alternative training methods. The NTEC study indicated that about 63 percent of the skills needed were already totally or partially taught with existing facilities. Furthermore, with the acquisition of training devices programmed for fiscal years 1979 through 1982 and the development of additional trainers, NTEC felt that adequate training in a simulator facility was possible.

In response to the DAS audit report, the Navy initiated an internal review of the feasibility of providing training in a simulator facility. This study confirmed the prior finding that a hot plant was necessary for complete training. NTEC participated in this study and notwithstanding its previous statements, found that maintenance simulator technology was not sufficiently refined to satisfy all training requirements.

While there are still divergent opinions about the cost-effectiveness of a hot plant vis-a-vis a training simulator, the Navy is seeking authorization and funding of the DD-963 hot plant. Due to funding cuts, it may be past the originally scheduled date of fiscal 1982 before the hot plant will be installed.

As an aside, the 1978 Rating Review Board approval of the new GS rating introduced a different training concept: a systematic progression from apprentice to senior systems technicians bridging the skills of different ratings and NECs. This concept originated in the personnel and training community in 1971. As a matter of fact, the FFG-7 SHAPM (PMS-399) adopted this concept from the beginning (November 1971), even though there was a long delay in obtaining Rating Review Board approval (SECNAV approval was given in 1975).

3. PROCEDURES FOR IDENTIFYING, EVALUATING AND CORRECTING DEFICIENCIES

INTRODUCTION

The Navy has numerous feedback systems for identifying shipboard manpower, personnel, or training deficiencies. They include: data peculiar to new construction ships or new subsystems, such as evaluations by OPTEVFOR, inspections by INSURV, deficiency reports by the SHAPM, and Fleet Advisory Systems; data peculiar to a new ship's crew prior to transfer to an operational squadron, such as evaluation by the Propulsion Examining Board (PEB); standard, Navy-wide data systems, such as CASREP, UNITREP, the 3-M system; and reviews/evaluations done on a cyclical basis, such as INSURV material condition inspections (for each ship once every three years), quarterly force reviews (QFR) for updating the shipboard PMS, and various TYCOM evaluations/inspections, including PMS inspections and operational readiness evaluations (ORE).

This chapter provides a brief description of the key feedback systems, including examples of their use in identifying manpower, personnel, and training deficiencies for the DD-963 class. These systems represent only a small portion of the channels available; informal mechanisms, such as message traffic from COs and TYCOMs through the chain of command and Commanders Conferences, are especially used for identifying potential manpower, personnel and training shortcomings. NTP and SMD conferences may also be viewed as a type of feedback channel and were addressed in Chapter 2.

OPTEVFOR

As the Navy's independent testing agent, OPTEVFOR is responsible for operational test and evaluation (OT&E) of new development systems. OT&E

comprises initial operational test and evaluation (IOT&E), which is conducted prior to the production decision, and operational test and evaluation follow-on (FOT&E), which is conducted afterwards. Ship OT&E differs from the normal test cycle because of the long construction period and the need for individual test programs for major equipments installed onboard. In a conventional lead ship-follow ship acquisition program, IOT&E is designed to permit adequate test and evaluation of new subsystems ashore (land-based test sites, if constructed) and at sea in surrogate ships, prior to release of funds for follow ship construction (Milestone IIIA), which occurs before the lead ship has been delivered. In a prototype ship acquisition program (RDT&E, N-funded), the prototype will undergo a full operational evaluation at sea prior to the production decision for follow ship acquisition (Milestone III).

The final subphase of IOT&E is known as OPEVAL. It is the most intense and realistic period of IOT&E for a new subsystem (or prototype ship) and uses personnel planned for fleet use. An OPEVAL of a new subsystem is normally required before approval for service use can be granted by CNO.

FOT&E is normally conducted with the lead ship or designated follow ship during the period between delivery and expiration of SCN funding or subsequently. While IOT&E is focussed upon an early assessment of operational effectiveness and suitability (the latter is defined by DoDD 5000.3 to include: availability, compatibility, transportability, interoperability, reliability, wartime usage rate, maintainability, safety, human factors, manpower supportability, logistic supportability, and training requirements), FOT&E is to validate that program objectives are met by production hardware. The early part of FOT&E is normally focussed upon the testing of fixes to be incorporated in production hardware, completion of deferred IOT&E, and continuing tactics development. The late part of FOT&E normally focusses upon

deficiencies identified during previous testing and completion of FOT&E. It includes validation of program objectives for operational effectiveness and suitability (especially reliability, maintainability, and logistic supportability, where the latter is defined by DoDD 5000.3 as the "degree to which the planned logistics (including test equipment, spares and repair parts, technical data, support facilities, and training) and manpower meet system availability and wartime usage requirements").

For the DD-963 class, IOT&E included combined development and operational testing of a new propeller capable of transmitting thrust in the 40,000 SHP range, yet capable of reversing pitch. (This testing was done on prototype installations aboard two frigates in support of both the DD-963 and FFG-7 programs). IOT&E also included a number of OPEVALs of some of the combat systems (e.g., Mk 86 GFCS) installed aboard other test ships (OPEVALs are not conducted at shore-based test sites, only in the operational environment).

FOT&E for the DD-963 included tests of the ship's mobility, as it had a new propulsion plant. OPTEVFOR conducted this testing in 1975/1976. The results were reported by OPTEVFOR in March 1977. Manpower, personnel, and training-related recommendations were as follows:

- Revise SMD to provide one engineman for each engine room and Number 1 auxiliary machine room for each of three watch sections, pending achievement of full automation of equipment and a reliable sensor/alarm system.
- Initiate system training for more supervisory personnel on an actual integrated propulsion plant.
- Increase the number of enginemen trained in both operation and maintenance of the gas turbine and control console.

A follow-on evaluation was conducted in 1977, with a letter report sent to CNO in November 1978. OPTEVFOR noted that none of its recommendations had been implemented and reiterated them. Notice that the August 1978 CNO-approved Class SMD provided the recommended engineering space watchstations,

but was effective only after OPTEVFOR's test period. In January 1978, the new gas turbine rating had finally been approved, with system-level training provided to FFG-7 personnel on the Navy's propulsion test site in Philadelphia. Although the DD-963 gas turbine is identical to that of the FFG-7, the control system differs significantly. Because no hot plant or training simulator is currently available for the DD-963, system-level training for DD-963 gas turbine personnel has to take place onboard ship.

When the new test and evaluation policy summarized above was established in early 1973 (DoDD 5000.3, Test and Evaluation, first issued January 1973, implemented in the Navy by OPNAVINST 3960.10), the CNO designated five acquisition programs, all past Milestone IIIA, including the DD-963, to comply with the new policy (Donovan and Fitzgibbons, 1977). Compliance consisted of "backfitting" the new policy to include FOT&E where a need existed.

One of the new ideas incorporated into DoDD 5000.3 was full ship FOT&E: "For all new ship classes, continuing phases of OT&E on the lead ship shall be conducted at sea as early in the acquisition process as possible for specified systems or equipment and, if required, for the full ship to the degree feasible" (emphasis added). Full ship FOT&E was not considered for the DD-963 and, to date, has not been conducted on any surface combatant ship other than smaller craft (e.g. PHM). The Navy did consider this issue for the first time for the FFG-7 and CGN-38 classes but decided against full ship FOT&E based on cost, the comprehensiveness of the development and operational tests and evaluations, and the questionable impact it would have on the follow ships already under contracted (Donovan and Fitzgibbons, op.cit.).

In summary, in the absence of full ship OT&E, OPTEVFOR is a source for identifying manpower, personnel and training deficiencies only for selected subsystems, not the whole ship.

INSURV INSPECTIONS

Material inspections are conducted by INSURV both for ships in commission and for new ships during acceptance and final contract trials. These inspections look at both material condition and equipment performance. To the extent that poor material condition is due to insufficient or improper maintenance procedures, INSURVs may identify personnel and training deficiencies. Recommendations may be made to review "A" school, "C" school, or fleet training. INSURV findings have a high visibility and impact. They are summarized quarterly to the CNO Executive Board (CEB); for final contract trials, they determine the responsibility for correction of deficiencies; and they enter the Class Advisory System maintained by the SHAPM and the Fleet Advisories of the TYCOMs. By policy (OPNAVINST 3960.10), INSURV's responsibility for production acceptance test and evaluation of new construction ships may extend to tests not specifically related to contract specifications and requirements, such as evaluations of reliability, logistics supportability, and system training and personnel qualification standards.

FCT reports for the DD-963 included the following findings related to manpower, personnel, and training:

- numerous deficiencies in facilities or facility maintenance
- need to man engineering spaces pending improvements in reliability of the automated sensor/alarm system
- performance of PMS averaged 68 percent
- Mk 86 GFCS deficiencies which caused several FCTs to be redone

The first finding may have contributed to the decision to expand the deck force from 25 (7 petty officers/18 non-rated) to 40 (7 petty officers/ 33 non-rated) in the August 1978 SMD (reflected in the MPA which became effective October 1979). The second finding was discussed earlier (see OPTEVFOR). The third finding either suggested insufficient manning or questioned the validity

of the PMS package. The fourth finding confirmed the problems the Navy had (and still has) with supporting the Mk 86 GFCS, in part due to training shortcomings and in part due to supply support, technical manuals, and support equipment problems (see Chapter 4).

CORRECTIVE ACTION PLAN

As long as a ship is within the SCN funding envelope, the SHAFM keeps overall management responsibility for correction of material deficiencies while the ship is under operational and administrative control of the TYCOM. The SHAPM maintains a class advisory system accumulating technical deficiencies as reported on each ship (from INSURV or other sources), identifying planned actions for each item, and removing items from the list as they are resolved. When SCN funding for a ship is terminated, management responsibility is transferred from the SHAPM to the SLM, and a manual of uncorrected technical deficiencies for that hull number goes along, with copies provided to OP-03, TYCOM, CO of the ship, and the SUPSHIP at the builder's yard. In the case of the DD-963 class, our review of recent sample manuals (Class Technical Problem Status Report, 15 May 1980; USS JOHN RODGERS (DD-983) Transfer Conference Book) did not reveal any items diagnosed as caused by manpower, personnel, and training deficiencies. Many items called for engineering changes to improve reliability or maintainability characteristics or to correct design deficiencies; some called for complete replacement. (With respect to the latter, the manuals included a summary of planned evaluations of prototype installations.)

In parallel with the SHAPM's class advisory system, the TYCOMs have their own advisory system documenting outstanding deficiencies and planned corrective actions. For the DD-963 class, NAVSURFPAC instituted a new management tool, the SPRUANCE class corrective action response program. It provided a

method for reporting problems and comparing conditions on several ships of the class prior to requesting/recommending corrective action from or to higher authority. Once corrective actions had been identified (by PMS-389, system commands, engineering support activities, or fleet), they were entered into a central documentation system, the corrective action plan. (This approach has since been institutionalized at NAVSURFPAC and is applied to the FFG-7 program in a more refined format, including manning and training as separate problem categories).

The data which filtered through this reporting system included several items pertaining to training deficiencies. An illustration of the types of information provided is shown in Table 3-1 for the Mk 86 GFCS.

Table 3-2 summarizes the current top fifteen technical problems identified by NAVSURFLANT as reported to CNO and CNM. Importantly, nine of the fifteen problems are personnel- or training-related.

LOGISTIC REVIEWS

As indicated earlier, there was no consolidated ILS plan for the DD-963 class in the format required under current acquisition policies. So, there was possibly more than usual interest by higher chains of command in the adequacy of logistic support for the ship class. An audit of the ILS planning and implementation for the DD-963 class was held in October 1978 by the NAVMAT Logistics Review Group (LRG) (the LRG was created by NAVMAT Instruction 4105.3, February 1978) and an audit team representing ASN(MRA&L), CNO, NAVSUP, and CNET, with NAVSURFLANT/PAC (TYCOM) representatives attending. The main criterion for this review was whether the need to redo final contract trials could be attributed to logistic support problems. (Of 14 FCTs held by that date, one required a complete retrial, seven partial retrials, and all cited mission-degrading and logistics deficiencies). Primary data sources included

TABLE 3-1. EXAMPLE OF CORRECTIVE ACTION PLAN INFORMATIONMKS6 GFCS

ORIGINATOR/DATA	REMARKS	ACTION
DD-964 29 October '76	Recommends engineering changes. Needs action taken as soon as possible.	CNSP
NSWES 5 November '76	ORD ALT only installed on DD-965. Installation on DD-964 would help solve problems.	
CNSP 12 November '76	Requests action from NAVSEA: DD-964 RAV is 1 April 1977.	NAVSEA
NAVSEA 2 December '76	No ORD ALTs available in RAV; design will not be completed prior to end RAV.	
NAVSEA 29 January '77	Mk-86 Advisory No. 1. Summarizes problems and actions taken: upgrading spares, ECPs and maintenance trainers.	
ISD 1 February '77	Failures impacting installation and check-out. Requests Navy expedite fixes.	NAVSEA
NAVSEA 18 March '77	Mk-86 Advisory No. 2. Module repair by ships is ruining modules. Supply parts not available until 9-18 months after funding.	
INSURV 22 April '77	Requests lists of parts usage since DD-967 acceptance trials. Needs list at FCT.	DD-967
ISD 24 May '77	Excessive production time required to groom to Navy standards. Spare parts and trained personnel lacking.	NAVSEA
CSD-9 25 October '77	Minutes of conference with CNSP and Lockheed representatives. Topics discussed: spare parts support, reliability, system performance, system alignment training, and product improvements. Forwards recommendations.	CCDG-5
CAP March '80	Summarizes history of low availability and degraded performance in heavy weather. Summarizes ECPs and ORDALTs approved or pending. Summarizes LRG review of May '78 which identified serious ILS deficiencies in training, funding, technical manuals and supply support. PMS-389 to continue product improvement program, ORDALTs and monitoring reprovisioning.	NAVSEA

CCDG-5: Commander, Cruiser & Destroyer Group (CRUDES) Five

CDS-9: Commander, Destroyer Squadron (DESRON) Nine (= fleet introduction squadron)

CNSP: Commander, Naval Surface Force, U.S. Pacific Fleet (NAVSURFPAC)

ISD: Ingalls Shipbuilding Division (Litton), Pascagoula, Mississippi

NSWES: Naval Surface Weapons Engineering Station

TABLE 3-2. TOP FIFTEEN TECHNICAL ISSUES OUTSTANDING FOR DD-963 CLASS

SYSTEM/SUBSYSTEM	DESCRIPTION	PROPOSED SOLUTION
Deck, bulkhead, fittings	Corrosion requiring excessive facility maintenance.	Polyurethane coating on topside deck. Main deck and sides repaired at yard using zinc paint primer. Topside fittings to be manufactured of non-corrosive material. Change general specifications to require metallic compatibility to avoid bimetallic corrosion in future designs.
Hot water heaters	Unreliability causes excessive repairs. Numerous failures of temperature control valve thermo elements, tube bundle ruptures, improperly sloped steam supply piping, and condensate piping deficiencies. Fixes to this personnel safety and sanitary related item have been slow and costly with minimal improvements.	Product improvements or replacement by electric hot water heaters.
ASROC weapon handling system	Interlock/switch failures cause equipment damage, inoperability of AWHs, inability to reload weapons, and possible damage to launcher.	Interim guidance to operators. NAVSEA evaluate product improvements. Review of training curriculum required.
Bleed air system	Valves are unique to DD-963, complex, and in short supply, but fail frequently. Failures cannot be repaired by ship force as operation and maintenance of this valve is not taught in school.	Establish Navy in-house capability to repair valves to reduce turnaround time. Establish rotatable pool with replacements available at overseas locations.
Electronic modules (PCBs) for the propulsion control system	Limited replenishment of on-board stock of PCBs causes long downtime for each failure and may make propulsion plant inoperable. SPCC policy is to hold the NKFI carcasses turned in by the ships and only issue repair contracts to support CASREP requisitions.	Develop capability to make minor repairs locally. Provide adequate funding to designated overhaul point for quick turnaround of all NRFI boards. Ensure requisitions are filled expeditiously to maintain required levels of on-board spares.
Mk86 GFCs	System has low reliability. Shipboard expertise inadequate to repair casualties without technical assistance. Supply support is inadequate. Loss of the system makes the ship unable to fulfill one of its primary missions.	NAVSEA's program to increase spare parts inventory has reduced system downtime but long-term solution is design changes to improve reliability. Training of technicians must be improved, emphasizing troubleshooting techniques: they are currently replacing parts in "Easter egg fashion," placing extra demands on an already short supply system. Provide schematics of black boxes to ships so that modules could be repaired by ship force in emergencies when no spares are available.
Waste heat boilers	Design makes any repairs difficult. Tube failures are a common occurrence, but replacement of a tube requires replacement of entire tube bundle. Tube bundles are not stocked; are long lead and expensive; and replacement is depot-level work requiring large hull access. All known feed treatment systems have been tried but no effective system has been found. Loss of boiler puts associated ship's service generator out of commission.	Band-aid fixes have been accomplished but do not solve the basic problem of poor design. Replace existing boiler with one of better quality and design, or eliminate the need for ship service steam. Require designated personnel to attend water treatment school. Establish rotatable pool for tube bundles. Develop SHIPALT to modify feedpiping.
CRP system	Numerous ships have experienced filter failures causing system degradation and ultimately resulting in loss of one of the CRP propeller systems. Hardware and operating procedure modifications over past 5 years have not solved the problem. Lack of system knowledge by ship's force compounds the problem.	In view of criticality and complexity of this system, a reliable fix is required. If system cannot be upgraded, a replacement system should be developed.
Gas turbine generators, high pressure air start valves	System reliability and design inadequate. Ship's force is not permitted to repair, but lead time for replacement is 1-3 months due to SPCC contracting delays. Interim action by SURFLANT authorizes local contractor repair of defective valves to help alleviate backlog.	Improve turnaround time of NRFI assets. Increase RFI stockage at each coast and aboard tenders. Develop specified design improvements. Consider development of portable start system external to the GTG similar to that used for aircraft.

TABLE 3-2. TOP FIFTEEN TECHNICAL ISSUES OUTSTANDING FOR DD-963 CLASS
(Continued)

SYSTEM/SUBSYSTEM	DESCRIPTION	PROPOSED SOLUTION
Gas turbine intakes, dimister pads	Mid-East deployment revealed vulnerability of air intakes to clogging with sand, causing need to rotate GTCs daily to clean out sand. This procedure in conflict with advisory guidance to operate GTC for 30 consecutive days. Metal clips holding the pads in place must be bent back to remove pads; they break after 1 or 2 removals, and are difficult to replace.	Redesign air intake system to operate in sandy conditions. Design modification kit for the dimister pad clips. Increase stockage of RFI pad sets at NSCs.
400 Hz converter	School graduate cannot troubleshoot and frequently must request tech assist from civilian tech reps. Casualties could be reduced by better training. Casualties to major assemblies require repair by manufacturer involving excessive turnaround times.	NAVSEA review training curriculum for 400 Hz converter technicians. NAVSEA sponsor a training team to visit ships and provide shipboard training on operation and repair of converters. Issue BOA with Teledyne to expedite turnaround of failed assemblies.
Gas turbine engine	IMA personnel are not authorized to supervise gas turbine engine change-out; instead, a civilian tech rep must be present at each change-out. Increasing numbers of gas turbine ships combined with the prospects of moving civilian tech reps to foreign ports in time of crisis are cause to reconsider IMA capability.	Develop PQS qualification for gas turbine engine change-out supervisor at IMA level. Review configuration control system to ensure that prepositioned engines have mandatory field changes installed.
GTM cooling fans	Failure rates are increasing. Change-out of equipment requires cutting a hole in the side of the ship. Equipment is a vertically mounted motor weighing several hundred pounds. Stress on lower bearing is aggravated by ship's rolling motion. Due to size and weight, alignment tolerances may be difficult to achieve by the average rigging crew.	NAVSEA investigate failures of fan and relationship to motion in heavy seas, and consider different bearings capable of withstanding greater stress or a new design fan.
Watertight doors, deck hatches and weather-decks	Aluminum dog hatches are poorly designed, poorly constructed, and difficult to maintain. Weatherdecks have little camber so that standing water is a constant problem. In a cold operating environment, ice will be a serious problem.	NAVSEA redesign watertight doors. NAVSEA authorize removal of designated flush deck hatches and install raised-lip hatches. Ensure adequate deck camber in new construction ships to alleviate standing water problem.
NATO SEA SPARROW missile system	System casualties are increasing with a longer mean time to repair. Shortages of experienced, qualified GMM's are causing decreased system readiness. Missiles become unreliable due to seeker head hydraulic leaks.	Review on-board spares allowance (COSAL). Ensure ships are manual to NMP for the GMMs to keep experience in the fleet. Improve quality control of missile assembly inspections.
SOURCE: First eight problems as identified in COMNAVSURFLANT message to CNO, 30 April 1980. Last seven problems as highlighted during CNM visit to NAVSURFLANT, 3 June 1980.		

the FCT reports, class and fleet advisory reports and contractor-prepared documentation.

Four issues surfaced related to manpower, personnel, and training, as documented in the audit report dated February 1979 and summarized in OP-01's point paper for the LRG meeting reviewing audit results:

- Neither the workload nor the location for the calibration of hull, mechanical and electric (HM&E) equipments has been determined; this could drive additional ship and/or IMA billet requirements.
- The maintenance concept does not provide for an electronic module screening capability aboard ship. Due to poor fault isolation performance on some of the complex systems, a proportion of modules returned for IMA or depot repair actually show no evidence of failure, i.e., are ready for issue (RFI). By providing the ship's force with necessary test equipment and additional training, modules could be screened to keep the RFI ones aboard.
- There is a shortfall in the ship's force's ability to accomplish PM/CM and still accomplish FM. While minimization of FM was a contractual objective, the number of people needed was underestimated. The manning increase provided in the final SMD will become effective October 1979, so that it is too soon to tell whether this problem has been resolved.
- Maintenance training for the Mk 86 GFCS technician is inadequate. While a revised NTP was approved and promulgated October 1978, its implementation will be subject to adequate technical documentation which has not yet been provided.

Following review, the logistics audit was forwarded by CNM in June 1979 for NAVSEA response. NAVSEA's response was as follows:

- The DD-963 class calibration program "will be centered on in-place calibration, whenever possible," pursuant to CINCPAC/LANT recommendations (even though NAVSEA previously had indicated that the IMAs wanted equipment removed from the ship for calibration at IMA facilities). No resources (personnel requirements, training, calibration equipment) were identified, however.
- NAVSEA is conducting a trade-off study to determine the cost-effectiveness of a module tester aboard ship.
- A program for reducing FM on DD-963, FF-1052, and FFG-7 class ships was initiated.
- Technical documentation in support of the Mk 86 GFCS NTP will be provided.

Following this response, CNM recommended and DCNO (Logistics)(OP-04) approved certification of ILS for the DD-963 class in April 1980.

OPERATIONAL CERTIFICATION PROGRAM

The Operational Certification Program (OCP) consists of a series of inspections and evaluations which a ship must pass before assignment to an operational fleet. The criteria for certifying ships are divided into three major categories: material, personnel, and training. To satisfy the personnel criteria, a ship must be adequately manned in total as well as have sufficient petty officers to provide experience and leadership in mission-essential ratings. A ship must also have technically qualified personnel capable of maintaining and operating installed equipment. To satisfy the training criteria, a ship must achieve basic training proficiency in assigned mission areas.

OCP normally begins with a Training Coordination Visit (TCV) by the ship's Immediate Unit Commander (IUC). The purpose of the TCV is to verify the status of personnel, manning, and training and to ensure that future events are properly scheduled. This includes a review of ship arrangements for appropriate trainer services.

The ship then undergoes a Combat Systems Qualification Test (CSQT). The CSQT inspects all electronics aboard the ship to ensure that systems function the way they were designed to.

Following the CSQT, the ship receives refresher or shakedown training. This begins with the Fleet Training Group conducting a Training Readiness Evaluation (TRE) to determine if the crew has been sufficiently trained on an individual basis to begin refresher training (for ships out of overhaul) or shakedown training (for new ships). The TRE ensures that TYCOM assist visits have been conducted; that the ship has received a minimum of a one-week Readiness-for-Sea period and a one-week Individual Ship Exercise period (which

may occur simultaneously with CSQT); that Personnel Qualification Standards have been established and are functioning; that departmental training teams have been established and are functioning, and that prerequisite training has been completed by key personnel.

The ship next conducts a series of exercises to provide basic team training to meet standard training requirements (STR) determined by the TYCOM. STRs are based on the TYCOM's estimate of the exercises necessary for a ship to attain sufficient training to participate in multi-ship exercises. However, STRs may be waived if necessary equipment is not installed, or curtailed when proficiency is clearly demonstrated. At the end of refresher or shakedown training, the ship normally gets an ORE. An ORE includes a battle problem, various operational exercises, and a specialty phase in antisubmarine warfare operations, antiair warfare operations, amphibious operations, or other appropriate mission areas. Satisfactory completion of refresher or shakedown training is defined as satisfactory completion of the ORE and related exercises as specified by the TYCOM. After completion of refresher or shakedown training, a ship receives an operational propulsion plant examination (OPPE). The OPPE is conducted by the fleet PEB which looks at equipment and training, both operations and maintenance.

The ship then undergoes Naval Gunfire Support Qualification tests and a Nuclear Weapons Acceptance Inspection. After completion of all training, inspections and exercises, the TYCOM, upon receipt of IUC recommendations, certifies the ship ready for fleet operations.

The OCP, as described above, lists the procedures for Atlantic Fleet operational certification. The procedure for Pacific Fleet certification differs in detail but follows a similar concept of technical assist visits, followed by exercises, readiness tests and an OPPE (see Table 3-3).

TABLE 3-3. DD-963 CLASS FLEET INTRODUCTION SCHEDULE (NAVSURFPAC)

WEEK AFTER COMMISSIONING	
1-3 4 5 6 7 8 9-11 12 13-15 16 17	Enroute San Diego with port visit Ammunition load (Seal Beach) followed by structural test firing Sonar accuracy checks (Long Beach) Inport (San Diego) workup for weapon systems accuracy test (WSAT) WSAT at sea Deperm San Diego Shakedown training by fleet training group (FTG) Prepare ready for sea (RFS), San Diego Enroute Pascagoula with port visit Final contract trials (FCT) Post shakedown availability (PSA) at Pascagoula, (10-14 weeks duration)
WEEK AFTER PSA	
1- 3 4 5 6- 7 8 9 10 11 12 13 14 15 16-19 20 21-23	Enroute San Diego with port visit Ammunition load (Seal Beach) followed by independent ship exercises (ISE) Mobile training team (MTT) training in preparation for operational propulsion plant examination (OPPE) Phase I Inport (San Diego) workup for ship qualification trials (SQT) SQT (Southern California operational areas) (SOCAL) SQT (Pacific missile range) Harpoon certification Human resources availability (HRAV) Combat systems readiness tests ISE (SOCAL) training for engineering casualty control (ECC) Upkeep period (UPK) at San Diego and nuclear weapons training MTT OPPE Phase II Intermediate maintenance availability (IMA)/UPK, San Diego Preparation for OPPE Training Readiness Evaluation (TRE) OPPE Transfer to new squadron

The OCP thus does not test or evaluate organic maintenance capability. The OPPE is an exception, but it only examines one area (propulsion system). For other systems, there are checks to make sure personnel have completed necessary "A" and "C" schools, but no evaluation of how well the school graduates have been prepared to perform their shipboard maintenance tasks. There are exercises to test operational proficiency, but unless equipment malfunctions during the exercise, maintenance capability is not tested.

CASREP SYSTEM

The CASREP system is used to advise the operational and administrative chain of command of equipment/material conditions limiting operational readiness. It is used with the UNITREP system to make operational decisions and allocate technical assistance and supply resources. CASREPs are submitted for mission-essential equipment or systems which fail to meet safe, reliable, and effective operating standards, when outside assistance is necessary to correct the problem or repair is not possible within a specified time limit (e.g., 48 hours for SURFLANT ships, 72 hours for SURFPAC ships if readiness is degraded to C3 or C4).

The data element of a CASREP report which addresses the cause of material damage/malfunction could be used to detect manpower, personnel, and training problems. This data element identifies planned or corrective maintenance not performed or performed incorrectly; personnel with required rate/ paygrade not on board; and inadequate, improper, or insufficient training. A review of CASREP reports for the DD-963 indicated that this opportunity for manpower, personnel, and training feedback is seldom utilized.

The Fleet Maintenance Support Office under NAVMAT-04 and collocated at Mechanicsburg, Pa., with the Ships Parts Control Center under NAVSUP, maintains a computerized data base of CASREP reports. A review of the historical

CASREP reports for the DD-963 and DD-964 revealed that this system was not used to report deficiencies in personnel or training. Most CASREP reports cited part failure or normal wear and tear as the cause of the problem. In some instances, personnel were cited as causing the problem, such as:

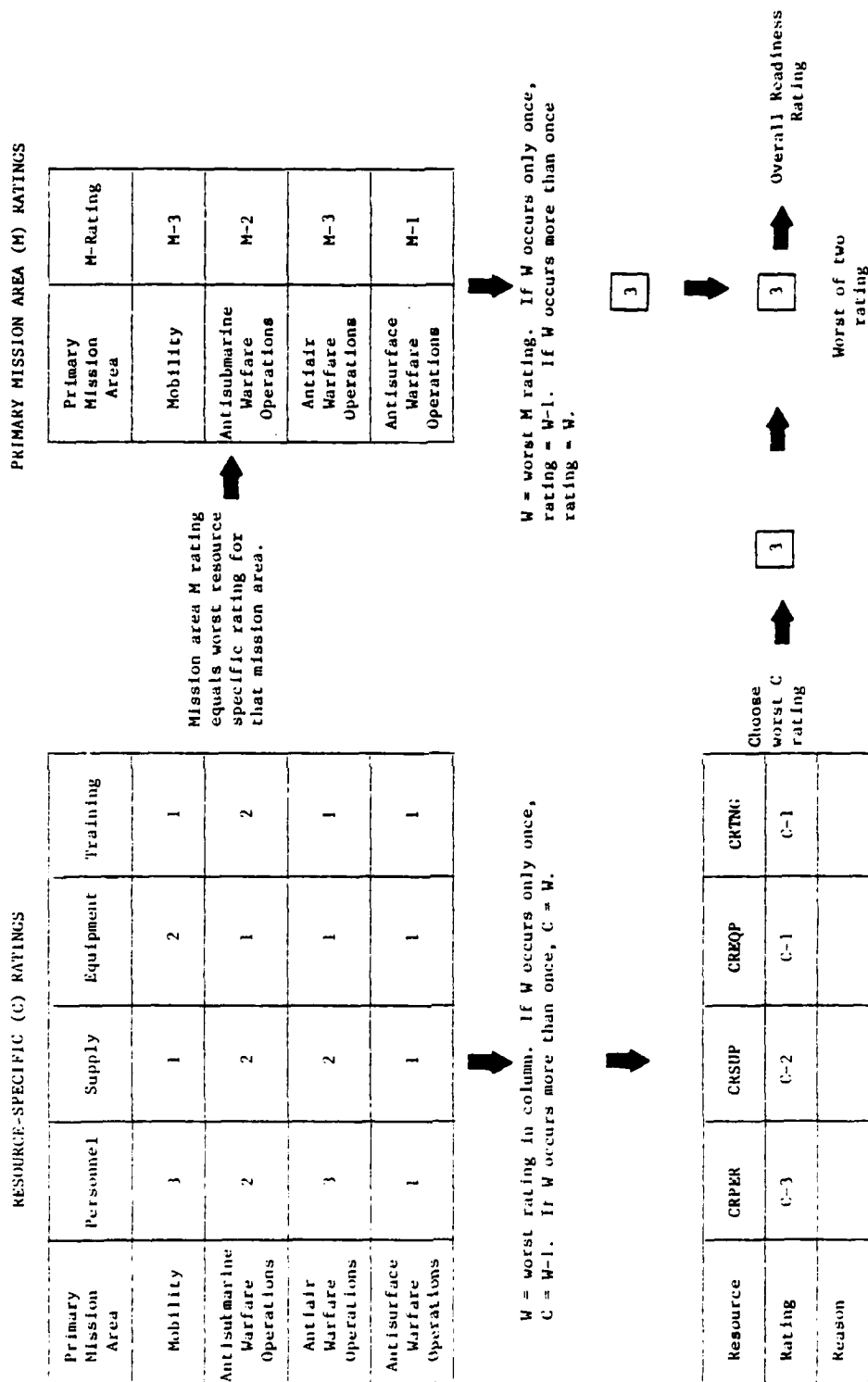
- use of improper tools
- lack of maintenance
- errors in conducting planned maintenance
- additional damage during troubleshooting

There were also instances when the cause of the problem was identified as "unknown." In many cases, the CASREP problem description stated that the ship's force's troubleshooting procedures could not locate the fault. Such problems may be caused by improperly trained maintenance personnel or by other factors (e.g., lack of test equipment, lack of time, lack of experience, beyond ship's force capability by design). In any event, the CASREP reports, by themselves, are not sufficient for identifying manpower, personnel, and training problems.

UNITREP SYSTEM

The UNITREP system is the primary vehicle for informing the CNO and the Joint Chiefs of Staff of the operational readiness status of naval units. UNITREP reports are submitted whenever a rating changes (e.g., following a casualty). UNITREP reports combine both resource-specific (C ratings) and mission (M ratings) areas to develop an overall readiness rating. Figure 3-1 is a simplified version of the worksheet used by the CO of a ship to develop the overall readiness rating. The figure is just an example. Since 1980, antiair warfare is no longer a primary mission area for the DD-963 class. Command and control (C²) is one of the other primary mission areas for this class of ships.

FIGURE 3-1. SIMPLIFIED UNITREP WORKSHEET



Readiness data are summarized in the combat operational ready/not ready (COR/CNOR) report submitted by the TYCOM to CINCFLEET. This report provides by type of ship the number of ships in each category and the corresponding CNO goals. COR is C-3 and better; CNOR is C-4 and C-5 (ships in overhaul). Ships with a C-4 rating are not operational unless the IUC has submitted a safe-to-deploy assessment to the chain of command (TYCOM-CINCFLEET-CNO). For ships that must deploy, the IUC must submit a safe-to-deploy assessment 30 days prior to deployment.

Personnel is the only resource area, and mobility the only mission area, where a C-4 (M-4) rating determines an overall rating of C-4. For all other resource (mission) areas, at least two must have a C-4 (M-4) rating for the overall rating to be C-4. The same rules for determining personnel readiness apply to both fleets. Personnel is C-4 in a given mission area under any one of the following three conditions: if the total number onboard is 69 percent or less of authorization, or if leadership (grades E5-E9) is 64 percent or less in a rating associated with that mission area, or if the NECs onboard are 64 percent or less of authorization for that mission area.

The training resource area is limited to operator training. Maintenance training is normally tied to a NEC and is reportable under the personnel resource area to the extent that NECs onboard are short of authorization.

UNITREP data suggest that the personnel system is providing good support to the DD-963 class. For example, in August 1980, SURFPAC had 39 ships rated C-4 in personnel out of a total of 157 ships; only one of 15 DD-963 class ships was rated C-4 in personnel.

In summary, UNITREP provides a feedback mechanism for identifying serious problems in personnel fill of authorizations, operator training problems, or critical NEC shortages.

3-M SYSTEM

The 3-M system was designed to improve material readiness in the fleet by facilitating efficient use of resources and retrieval of maintenance data needed to improve maintenance engineering analyses. Aboard ship, it is used to schedule maintenance tasks as well as report and disseminate maintenance-related information. There are two major subsystems within the 3-M system: the Planned Maintenance Subsystem (PMS) and the Maintenance Data Collection Subsystem (MDCS). The PMS pertains to the planning, scheduling, and management of personnel and material to accomplish preventive maintenance. The MDCS is used to record the expenditure of resources (personnel and material) associated with corrective maintenance actions and to identify deferred maintenance.

The PMS for each ship is defined by Maintenance Index Pages (MIP) and associated Maintenance Requirements Cards (MRC). The latter specify, for each preventive maintenance action, the periodicity, rate/rating/NEC, and estimated man-hours. The PMS Feedback Report (OPNAV Form 4790-7A) is used to provide a line of communication between the TYCOM and the CNM. It is used to make recommended changes to PMS documentation. A Supplemental Report Form (OPNAV Form 4790-2L) may be used with the PMS Feedback Report to provide additional space for sketches, comments, etc. The ships send the 4790-7A to the appropriate Navy Maintenance Management Field Office (NMMFO) via the TYCOM. The NMMFO will perform an initial review, notify the cognizant systems command, and process the feedback report as directed by the systems command. The systems command will complete action on the feedback report, submit to the CNM, on a quarterly basis, a consolidated summary of action taken on feedback reports, and distribute applicable portions of this summary to the TYCOMs.

Revised PMS documentation is provided through the Quarterly Force Revision (QFR) program, updating MIPs/MRCs as required.

The PMS feedback system is oriented primarily toward problems with inadequate technical documentation, unsafe procedures, incorrect tools, etc. It is not designed to report inadequate personnel or insufficient maintenance training and is therefore of little use in identifying manpower, personnel, and training deficiencies.

Data input into the MDCS is by Maintenance Data Form (OPNAV Form 4790-2K). These forms document all maintenance performed or required beyond routine preventive maintenance defined by the PMS. The "2K" forms thus cover:

- Completed Maintenance Actions, including:
 - all reportable corrective maintenance
 - PMS actions for which the MRC specifies use of repair parts
 - PMS actions requiring meter readings or tolerances to be reported
 - any PM other than PMS
- Deferred Maintenance Actions
 - CM not accomplished due to lack of parts, skills, or test equipment
 - PM not accomplished due to operations or need for outside assistance
- Work requests for outside assistance

The MDCS thus provides, conceptually, a feedback mechanism for identifying skill deficiencies (excessive requests for outside assistance for organizational-level maintenance tasks) or manning deficiencies (excessive deferrals of PMS). As noted earlier, the rate of PMS performance measured this way was used in assessing the adequacy of DD-963 manning (see INSURV and LRG sections), but the steep growth in PMS workload for the DD-963 generated some questions about the validity of PMS requirements. (As noted later under

Fleet Inspections, the rate of PMS performance is also an indicator of interest to the annual 3-M inspection aboard ship by the IUC.) For example, one issue has been the development of PMS for valves and the extent to which such PMS tasks can be performed by watchstanders while on watch. In contrast, we have seen no evidence that the MDCS data were ever used to assess skill deficiencies. Like the CASREP data, the MDCS data are maintained in a centralized data base, and selected report formats are available to retrieve data upon request. One problem, apparently, is the unknown accuracy of the MDCS data. Another problem is that the actual work performed by outside technical assistance (MOTU, contractors, etc.) is not documented at the level of specificity required to identify the precise nature of the ship's force skill deficiencies (if any).

DETECTION, ACTION, RESPONSE TECHNIQUE

The Detection, Action, and Response Technique (DART) program, created in 1971, is directed by the CNM and designed to identify and correct serious equipment problems affecting Navy-wide fleet readiness. It covers specific shipboard equipments (including aviation systems/equipments integral to the ship) which are selected annually for DART management subject to a given budget ceiling. Table 3-4 lists the current DART equipments. The objectives of this intensive management program are to identify the causes of serious material readiness problems; to identify the resources necessary to evaluate and correct these problems; and to implement the corrective actions necessary to attain acceptable levels of performance, reliability, maintainability, and availability. Nominations of systems or equipments for the DART roster may originate from the systems command, the fleet, or the CNM. Equipment selection is done in an annual meeting of fleet, NAVMAT, and cognizant systems command flag officers.

TABLE 3-4. EQUIPMENTS ON THE DART ROSTER

FY80 Items Retained in FY81	FY80 Items Deleted in FY81	FY81 Candidates For Inclusion	FY81 Items Selected
Air Systems - H.P.	O ₂ N ₂ Systems	Mk 86 GFCS	
Air Systems - L.P.	Forced Draft Blowers	400 Hz MG Sets	X
SPC-55	Central Dry Air	SPC-51	X
Boilers	SPS-40	SPS-52	
Firepumps		Amphibious Support (Stern Gates)	X
Main Feed Pump		IVDS Doors	
Air Conditioning/Chilled Water		5"/54 - Mk 45 Gun	
SPS 48		Mk 26 GMLS	
JP-5 Fuel		URT - 23 (HF)	
SPN-42		SPN - 43	
Elevators			
Steam			
SSDC on FFG 7 Class			

The Deputy CNM (Logistics) is the Executive Director of the DART program. The DART Program Director (DPD) is designated by NAVSEA and is responsible to the Executive Director for operation of the program. The DPD's responsibilities include (NAVMAT Instruction 4790.10B):

- coordinating, developing, and screening equipment nominations for the DART program (received from SYSCOMs, FLTCINCs, and CNM)
- coordinating the program to minimize duplication of effort
- participating in the Executive Director's review of progress and corrective action effectiveness
- acting as the single point of contact at NAVSEA
- promulgating operating procedures for the program
- ensuring that DART Equipment Managers (DEMs) submit information necessary to support program funding requirements, notifying the Executive Director and the CNM of proposed changes in program funding levels and preparing resource justification documentation
- notifying the CNP or CNET points of contact to provide representation at program reviews for equipments having personnel or training-related problems.

NAVSEA, NAVAIR, and NAVELEX are responsible for:

- nominating problem equipment candidates
- selecting DEMs
- ensuring that DEMs submit programs and progress reports to the DPD for approval
- ensuring that adequate DART program funding is requested and supplying the DPD and the CNO equipment support and installation sponsors with backup data
- granting priority attention to matters affecting the DART program
- requesting approval from the CNM, the Executive Director, and the DPD prior to making funding cuts in the program.

NAVSUP is responsible for assigning a program manager for each DART equipment to ensure priority handling of supply support matters, performing requested supply support analyses and taking appropriate action to improve supply support. The CNP (DCNO, MP&T) and CNET are responsible for designating points of

contact, developing plans for the resolution of personnel and training problems with DART program equipment, and attending program reviews.

The only equipment aboard the DD 963 which was part of the DART program is the AN/SPS-40B radar set. The AN/SPS-40 series is a long-range air surveillance radar set which was introduced in 1961. In 1968, an improved version, AN/SPS-40A, was introduced. Both versions experienced low reliability and availability. The demonstrated mean time between failures was 60 hours for the AN/SPS-40 and 100 hours for the AN/SPS-40A. Both were considered insufficient for fleet needs. To correct this problem, the AN/SPS-40 DART program was initiated in March 1971. Reliability improvements were made when the AN/SPS-40B was developed for the DD 963, LHA and CGN-38 ships. In addition, improvement kits, AN/SPS-40C for the AN/SPS-40 and AN/SPS-40D for AN/SPS-40A, were developed. The AN/SPS-40B/C/D radar sets then achieved the DART program goal of 200 MTBF.

Since the introduction of the AN/SPS-40B/C/D, ongoing DART analysis has indicated that, although the reliability goal was met, further improvements in availability would be possible through:

- improved distribution of shipboard technical personnel
- improved training programs
- improved reliability and maintainability of certain units
- improved documentation
- improved supply support
- improved reliability and supportability of radar support systems (e.g., ship's central dry air system, water coolant system).

These findings are based on data collected by a NAVSEA ship assist team (SAT) which visited several ships to identify the causes of the problems and determine if the DART program and integrated logistics support actions were

correcting known problems. The first two of the above findings are directly relevant to our case study.

The assist team found that one of the ships had been using an electronics technician (ET) to maintain a radar on which he had no formal training. (Subsequent analysis by NAVSEA revealed that 65 of the 152 installed sets had at least one billet unfilled.) The assist team also found that all ETs interviewed felt that there were areas needing additional coverage during the training process. The proposed solution to the personnel problem was to give visibility to it and establish better personnel distribution procedures among ships. The proposed solution to the training problem was to develop audio-visual training aids for students and fleet personnel. Additional details on SPS-40B personnel and training related problems are provided in Chapter 4.

CURRENT SHIP MAINTENANCE PROJECT

The CSMP is the accumulation of deferred maintenance requirements as documented by the Maintenance Data Forms (OPNAV Form 4790-2K). When a ship is scheduled to go into overhaul, the CSMP is the starting point for the development of the work package in addition to the planned ship alterations. Normally, a pre-overhaul test and inspection team (PERA and shipyard technicians) visits the ship several months prior to overhaul to determine material condition and initiate development of the work package. The CSMP computer printout is then reviewed, items are added or deleted, and the resulting list is reviewed at the work definition conference prior to overhaul. For the DD-963 (which entered overhaul the end of August 1980), the CSMP summary of 30 June showed a total of 14,900 deferred manhours of ship's force maintenance (Table 3-5).

Because we noted from the detailed job listing that many of the thousands of items (570 pages of computer printout) did not include estimated manhours,

TABLE 3-5. DEFERRED MAINTENANCE DD-963

DEPARTMENT	DEFERRED MAN-HOURS	
	Ship	IMA
Deck	2	50
Engineering	11,818	6,717
Navigation	109	50
Operations	1,852	1,601
Supply	249	545
Weapons	852	2,501
TOTAL	14,902	11,464

we queried the N-4 (Materiel) staff at NAVSURFLANT about the accuracy of the above figures. We were told that the total figure for deferred manhours could roughly be doubled and that a CSMP with 30,000 deferred ship's force manhours was not unusual for a ship of the size of the DD-963 entering overhaul.

In view of their apparent inaccuracy, we did not analyze these data further, even though the "deferral reason code" associated with each job would permit assessing the extent of deferrals due to lack of training (as opposed to other causes such as lack of documentation, equipment, parts, maintenance level).

FLEET SUPPORT

The normal feedback channels for material readiness in the fleets are as follows. For selected systems, the Fleet Analysis Center (FLTAC) conducts operational assessments of equipment reliability on the basis of CASREPs, other fleet message traffic, and special evaluations. These data go to the equipment in-service engineering agent (ISEA) concerned. (Each equipment has a cognizant ISEA, which may be a Naval Sea Support Center, a NAVSEA Division or another NAVSEA engineering activity such as Naval Ship Weapons System Engineering Station (NSWSES)). The ISEA is responsible for monitoring equipment

reliability, availability, and maintainability (RAM) characteristics and for identifying problems requiring corrective actions. The focus of the ISEA is primarily on reliability and availability. Typical corrective actions which may be recommended by the ISEA in the case of poor operational availability include engineering changes or alterations; approval is through the chain of command via the equipment manager in the cognizant systems command (e.g. NAVSEA, NAVELEX). The latter communicates actions taken by means of advisories, speed letters or other message traffic. Under normal circumstances, this entire feedback loop is engineering-oriented and will seldom address personnel issues, such as training inadequacies. It may address, when necessary, inadequacies in technical manuals, supply support problems, or test equipment issues.

When a shipboard equipment malfunctions and remains down beyond TYCOM-dictated time limits, the ship must submit a CASREP. If it is mission-essential equipment, it must also submit a UNITREP. If the ship's force is unable to repair the malfunction, the ship can so identify in its casualty report or subsequent casualty status reports and request technical assistance. When the ship is in CONUS, assistance in correcting electronics and ordnance equipment problems will normally first be provided by the closest mobile technical unit MOTU. Additional support is available from tenders, SIMA, NAVSEACEN, NAVSECDIV, or contractors.

MOTUs are under the functional sponsorship of NAVSEA. Five units are assigned to the Atlantic Fleet for fleet support: MOTU 2 (Norfolk, Va.), 4 (Newport, R.I.), 6 (Naples, Fla.), 10 (Charlestown, N.C.), and 12 (Mayport, Fla.). MOTUs are of special interest to this case study because their primary mission is to provide OJT in electronics and ordnance skills to ship's force personnel. MOTU assistance is supposed to consist of providing the technical

expertise and direction, while shipboard personnel perform the actual repairs using their own tools and test equipment. The type and extent of technical assistance required by a ship provides a possible indicator of the ship's force's technical capabilities (training and experience) in the electronics and weapons maintenance area. Table 3-6 summarizes the MOTU data we collected. Unfortunately, without a detailed documentation of what maintenance tasks for which reasons were performed by MOTU personnel, the available data do not lend themselves to the construction of meaningful indicators of ship's force skill deficiencies (if any). It is up to the ship whether 2K forms are written reflecting the technical assistance provided by MOTU; some ships do, most ships do not. As a result, the consolidated MDCS data bank at FMSO, Mechanicsburg, Pa., does not provide complete maintenance data on each piece of equipment. The MOTUs themselves keep detailed records for bookkeeping purposes; these data must be combined manually with MDCS data to assess such critical maintenance indicators as MTTR and percent of maintenance actions performed by the ship's crew. Even then, these indicators may be misleading as they do not account for contractor assistance beyond MOTU; do not reflect quality of repair, especially fault isolation problems as indicated by "false module returns" (information which must be obtained from the depot level); and are based on inaccuracies in the 2K forms themselves (especially, the tendency to attribute part of the active repair time to logistic downtime, i.e. awaiting parts).

Contractor support is not documented in detail, just the work hours charged. Thus, no precise data are available to assess the maintenance capabilities of the ship's force nor the quality of the repair work done. NAVMAT is currently requiring more detailed documentation of the maintenance actions performed by technical assistance (especially, to get better data on the

TABLE 3-6. LEVEL OF MOTU TECHNICAL ASSISTANCE (ATLANTIC FLEET)

BILLETS/MANHOURS (TOTAL) ¹		1978	1979	1980
Authorized Billets (On-Board Personnel)	Mil.	244(176)	244(192)	258(205)
	Civ.	18(18)	18(17)	22(17)
	CETS	76(68)	72(70)	80(72)
	Total	338(262)	334(279)	360(294)
Total Manhours to Atlantic Fleet		266,172	252,171	283,297
Manhours Provided to USS SPRUANCE ²				
1201: Travel to/from in excess of 2 hours		8	38	50
1203: Special fleet programs		2	10	34
1205: Prepare for readiness reviews		667	541	109
1206: Techn. Assist/OJT (without CASREP)		332	698	319
1207: Techn. Assist/OJT (with CASREP)		381	336	325
Total Manhours Support to DD-963 ³		1,390	1,631	845
Number of Visits/Number of Equipments				
1205		25/14	25/20	8/3
1206		28/15	50/26	31/16
1207		22/15	21/14	21/14

Equipments Requiring Multiple Tech. Assist (MOTU) Visits (# Visits/# Manhours)

EIC	DESCRIPTION	1206	1207	1206	1207	1206	1207
L000	Navigation Systems (Elec.)		4(44)				
QKOV	AN/UYK-20(V) Data Processor		4(88)	1(4)			
R162	AN/SQR-17, Sonar, Detection	6(117)	1(12)	6(102)	3(28)	3(48)	2(25)
R168	AN/SQS-53, Detecting, Range	5(40)	1(2)	5(58)	4(96)	1(8)	
JJ00	Launching Group Mk16 Mod 0		2(84)				
QD6G	AN/SRC-31B, Radio Set		2(24)				
N90R	AN/URD-4B, Direction Finder	1(36)	1(47)				
N81P	AN/WLR-1C Receiving Set	1(24)	1(24)			1(4)	1(40)
QD1M	AN/PRC-41, Transceiver	2(20)					
R911	AN/WQR-2, Receiving Set	2(16)					
LC00	Log System, Underwater, CI	2(16)					
QF1E	AN/KWR-37, TSEC	2(15)		2(12)			
QHQQ	AN/SKR-4, Terminal, Tele	2(7)		3(24)	1(12)		
Q31B	AN/UCC-1D(V), Terminal				2(28)		
QF10	TSEC/KW-7		1(16)	1(16)	2(8)		
OU59	AN/SYQ-7(V)2, Communicate			5(84)	1(8)		
P31R	AN/SPS-40B, Radar Set			4(84)	1(44)	1(16)	
QMO6	AN/UYA-4(V), Display Group			3(84)		3(56)	
P61E	Mk12 ALMS System, IFF			2(36)			
QP15	AN/WSC-3, Communications			2(31)			
L60B	AN/URN-20B(V)1, Radio Set			1(8)		1(8)	3(42)
QMS2	CV-3253/UYK Digital						3(41)
LMO7	AN/SRN-18, Navigation Set					2(44)	2(79)
LB33	Gyrocompass, Mk27 Mod 1						2(34)
P11P	AN/SPS-55 Radar Set			1(24)		1(4)	1(2)
G300	GFCs					4(16)	
G333	Optical Sighting System					3(32)	
G322	AN/SPO-9 Radar Set					2(16)	
TF04	Dry Air System					2(12)	

¹ Billets/on-board personnel as of 30 June, manhours reported on a non-calendar year basis, April through March.

² Manhours reported by year ending 30 June of calendar year indicated.

³ Manhours include 8 hours school training (Program Code 1204).

repairs required to correct poor quality or unauthorized repairs by the ship's force).

FLEET INSPECTIONS

In addition to the series of inspections described previously under the Operational Certification Program, there are two other types of inspections which might reveal personnel and training shortcomings. These are the 3-M (or PMS) inspection and the personnel qualification standards (PQS) inspection. Both are done annually by the IUC and reported to the TYCOM.

The 3-M inspection reviews the proper installation, administration and management of the PMS. It includes spot checks of work accomplished, not accomplished, and rescheduled. One of the evaluation parameters is the percent of PM actually accomplished in past 13 weeks (CNO goal is 75 percent). The TYCOM staff personnel we interviewed during this case study consider the operational propulsion plant examination (OPPE) and PMS inspection as the most critical fleet inspections.

The PQS inspection concerns only the qualification standards of watchstanders. (Development of new PQS for maintenance personnel was discontinued by OPNAV several years ago.) The inspection consists of several parts: an administrative part, including a review of the PQS program installed onboard (program charts, instructions, etc.), similar to the administrative part of the PMS inspections; a performance evaluation part which checks the attainment rate (number and percent of people who have completed PQS); and a validation part which entails random selection and testing of watchstanders. The latter might be limited to asking questions (skills/knowledge test) or might include hands-on demonstration of operator and planned maintenance tasks.

The PQS inspection provides a potentially valuable source of feedback information to CNET, but like the PMS inspection, it is not designed to assess corrective maintenance technical skills.

PROFESSIONAL ADVANCEMENT REQUIREMENTS

One potential source for feedback information on technical skill competency and quality of training is the performance of crew members vis-a-vis established professional advancement requirements (PAR). Enlisted personnel must demonstrate to their supervisors that they are capable of performing the tasks listed on PAR sheets (previously referred to as "practical factors"). Once they have demonstrated these capabilities to their supervisor's satisfaction, and if they are recommended by their supervisor and meet time-in-grade/time-in-service prerequisites, enlisted personnel become eligible for a promotion examination. Only if they pass do they become eligible for promotion; their actual promotion depends on examination score and fitness reports (quarterly evaluations by supervisors).

The Navy's promotion logic, summarized above, clearly is designed to meet skill competency standards in promoting enlisted personnel. It also provides feedback to CNET in terms of the difficulty school training graduates may have in meeting PAR sheet requirements. The quality of the PAR (i.e. extent to which it provides a comprehensive listing of representative skill requirements) is key to the effectiveness of the whole approach.

SUMMARY

The feedback systems effectively identify manpower, personnel, and training deficiencies in the operations area. The various inspections, drills, exercises and evaluations ensure that personnel is either adequate in quantity and well trained or that deficiencies will be visible and corrected.

Of the feedback systems reviewed, the DART program provides the best means of identifying and evaluating manpower, personnel, and training problems in the maintenance area. This program pulls together fleet, fleet support, and SYSCOM personnel to study the equipment's symptoms, determine the real

cause of the problem, and develop solutions. The other feedback systems such as UNITREP, CASREP, and 3-M, are useful in identifying that a problem exists, but seldom provide the depth of data needed to determine the basic cause of the problem.

4. OPERATIONAL AVAILABILITY OF SELECTED COMBAT SYSTEMS

INTRODUCTION

The bottom line for any assessment of the adequacy or inadequacy of manpower, personnel, and training is whether or not the operational availability (A_o) of a combat system is adversely affected. While reliability has the greatest impact on availability, lack of maintenance capability affects A_o through excessive repair times or waiting time for technical assistance, as expressed in the following standard formula:

$$A_o = \frac{MTBCM}{MTCBM + MDT}$$

where: MTBCM = Mean time between corrective maintenance actions
MDT = Mean down time
= MTTR + MLDT + MADT
MTTR = Mean time to repair
MLDT = Mean logistic delay time (awaiting parts)
MADT = Mean administrative delay time (including waiting for outside technical assistance)

Once lack of maintenance capability (as opposed to poor system reliability, unresponsiveness of the supply system, or operator skill deficiencies) has been identified as the cause of an unacceptable level of A_o , there are many factors which may explain it, including:

- lack of adequate technical documentation
- lack of tools or test equipment (either not on the ship's allowance list or inoperable or sent off-ship for calibration)
- poor performance of built-in test equipment
- higher priority operational requirements
- the right skill (NEC) not onboard
- training shortcomings

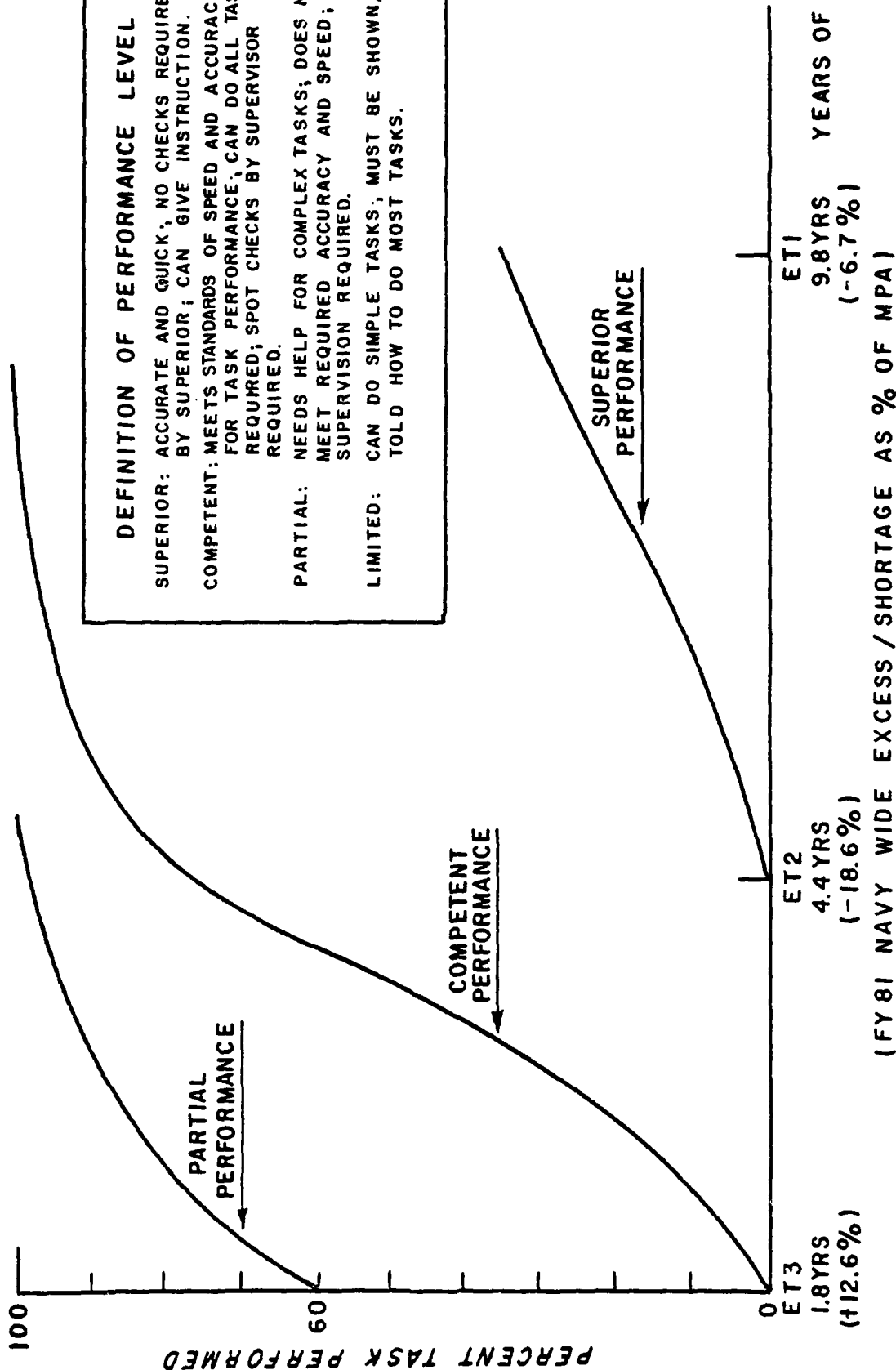
For many of the more complex maintenance tasks, such as electronics troubleshooting, experience (or availability of an experienced supervisor) is a requirement for successful performance. A recent study conducted by the Naval Research Personnel Research and Development Center reported on the relationships between experience and maintenance task performance (Koehler, 1979). This report suggests that at the E-4 level the average ET can do 60 percent of his tasks only partially and must be shown how to do the remaining 40 percent. He is not competent in any task. At the E-5 level (ET2), he is competent in about 80 percent of his tasks. Only at the E-6 level, after approximately ten years of service, is the average ET fully competent in all tasks and has achieved superior capability, including the ability to provide OJT instruction, in 40 percent of the tasks. (See Figure 4-1.) These findings are confirmed by other researchers (as reviewed in Nauta and Bragg, 1980).

What all of the above suggests is that assessment of manpower, personnel, and training adequacy for a ship like the DD-963 is a complex task. It would require detailed analysis of specially collected data: the MDCS data do not include operating hours of equipments; the CM manhours data, by all reports, are incomplete; the precise tasks performed by technical assistance are undocumented; the Navy's attempts to synchronize the UNITREP and CASREP reporting systems (for mission-essential equipments) so far have not been successful; and multiple causes may contribute to observed availability deficiencies necessitating on-site surveys for proper diagnosis.

Our task is not to assess manpower, personnel, and training adequacy for the DD-963. Rather, our purpose is to provide an example of: the types of analyses conducted by the Navy for "troubled equipments"; the time elapsed

FIGURE 4-1. SKILL LEVELS VERSUS MAINTENANCE TASK PERFORMANCE

AVERAGE PROFILE FOR ET RATING



SOURCE: "AN ENGINEERS' GUIDE TO THE USE OF HUMAN RESOURCES IN ELECTRONIC SYSTEM DESIGN," HUMAN FACTORS RESEARCH INC. AND NAVY PERSONNEL RESEARCH AND DEVELOPMENT CENTER, NPRDC TN 79-8, JUNE 1979.
(PERSONNEL AVAILABILITY DATA FROM E.A. KOEHLER, M.A. MILLER, "MANPOWER AVAILABILITY - NAVY ENLISTED PROJECTIONS FY-79-85," NPRDC SR 80-5, DEC 1979.)

before official recognition of personnel or training deficiencies as contributing causes; the process used to improve training or increase skill levels; and the resulting impact on operational availability. The systems chosen for this purpose are the AN/SPS-40B air search radar and the Mk 86 Gun Fire Control System (GFCS). The former was under DART management until October 1980; the latter was nominated for the DART program but not selected. Both are mission-essential systems; any downtime beyond TYCOM-determined limits will affect reported mission readiness of the ship.

AN/SPS-40B RADAR SET

The AN/SPS-40 series radar is the major 2D long-range air search radar in the U.S. Navy. It was introduced into the fleet in 1961. Its low reliability (MTBF of 60 hours) led to an improved version, SPS-40A, which was designed for and demonstrated 100 hours MTBF. A new design, incorporating solid state components and meeting the fleet's goal of 200 hours MTBF, was developed and approved for service use in 1970 (no OPEVAL was conducted prior to fleet introduction). This was the SPS-40B, installed on the DD-963 class ships (as well as the LHA and CGN38 class). Subsequently, conversion kits were developed to upgrade the older models to similar configuration and reliability/availability/maintainability characteristics as the SPS-40B. These converted models are identified as the SPC-40C (converted from SPS-40) and SPS-40D (converted from SPS-40A). This conversion process is still underway, with the phaseout of SPS-40/40A scheduled for completion by fiscal 1985.

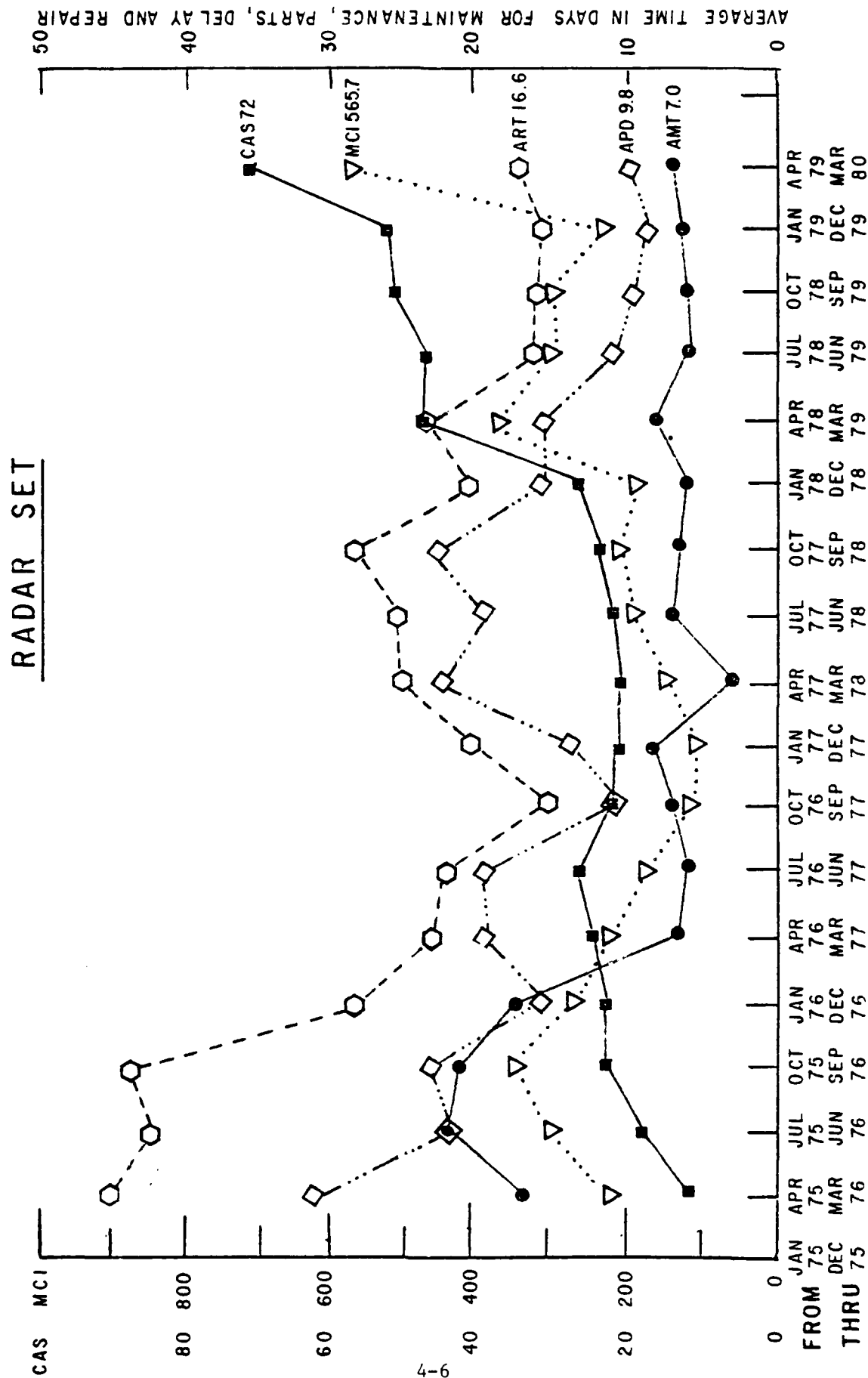
The SPS-40B is a relatively complex system. It is composed of 24 major units, comprising a total of 184 line replaceable units (printed circuit boards (PCBs) and modules). It has no built-in test equipment other than up/down indicators on some units. Manual troubleshooting requires a variety

of general-purpose test equipments and one special test equipment (sweep oscillator). The maintenance concept is shipboard repair through replacement of failed modules, and depot-level module repair through replacement of failed components, except for throwaway modules identified by the source, maintenance and recoverability (SMR) code. The radar set demonstrated an MTTR of 2 hours during first article test, but in fleet usage the MTTR has hovered between 7.7 hours (DART estimate) and 6.0 hours (based on "2K" data). The failures resulting in CASREPs are concentrated in a few major units: unit 4 (RF power amplifier) (36 percent), unit 6 (RF driver amplifier) (11 percent), unit 2 (modulator power supply) (10 percent), unit 5 (receiver) (10 percent), and unit 12 (antenna, reflector, pedestal) (7 percent). These data are for calendar year 1979.

In view of its low operational availability, the SPS-40 series was included. For the SPS-40B, the program focussed upon logistic support because the availability problems were attributed to poor supply support. At the time, only 6 spares were authorized in the SPS-40B Allowance Parts List (APL). As a result, system failures resulted in demands for spares not on board, causing logistics delay times which, in many cases, exceeded 120 days. Under the DART program, attempts were made to improve supply support. Quarterly DART reports provided trend data, such as illustrated in Figures 4-2 and 4-3. Definitions of the indicators are given in Table 4-1. (Notice that the number of SPS-40B radar sets installed increased from 0 in 1971 to 31 in December 1978, 40 in December 1979 and 44 in April 1980). Increases in the APLs through temporary overrides of the standard stockage logic were not effective.

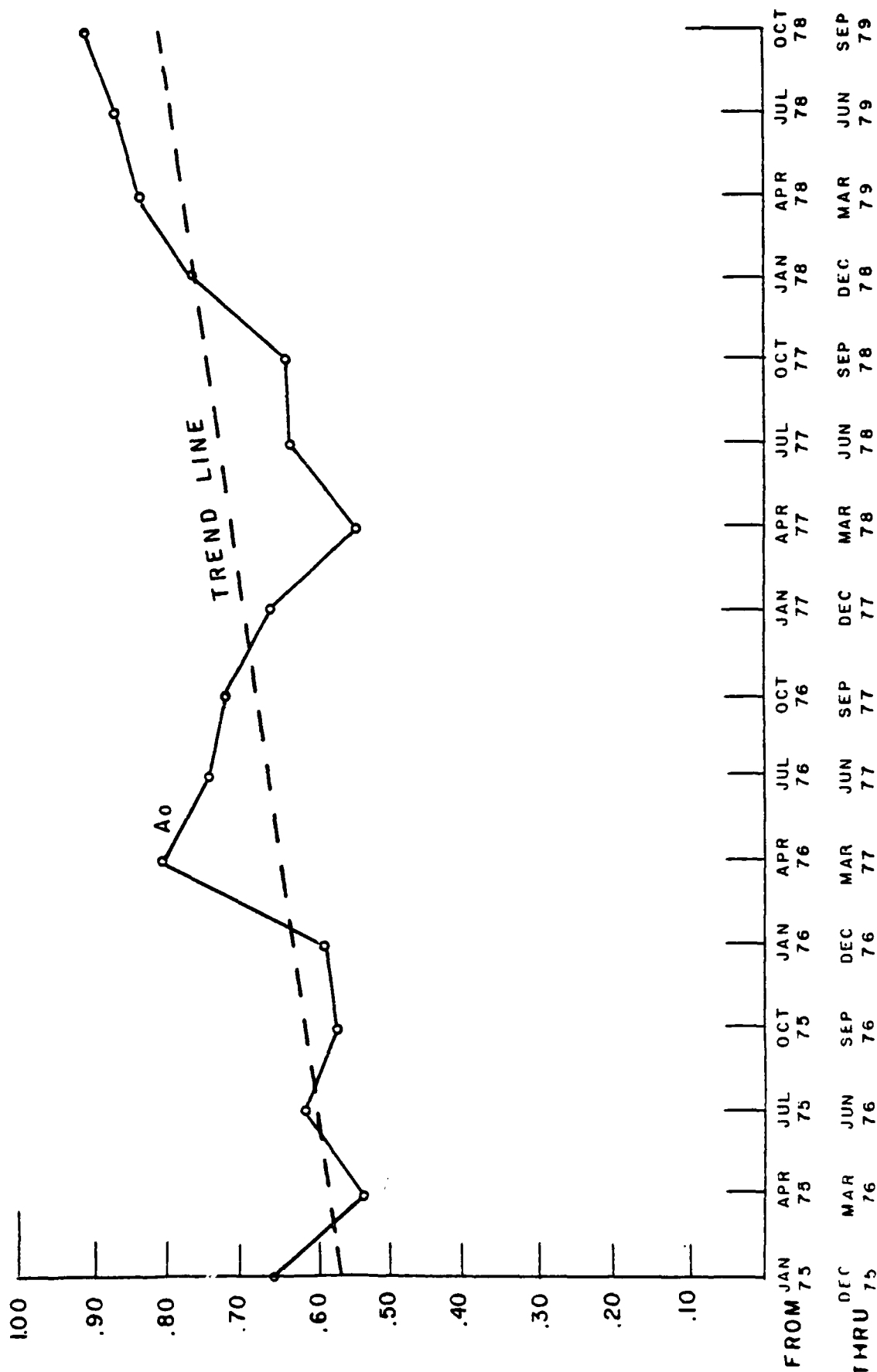
A Pack Up Program (PUP) concept providing a fleet unit (8 ships in company) with an augmented set of spares installed aboard one of the ships was also evaluated. A PUP kit was installed aboard DD-963 in October 1978; it was

FIGURE 4-2. LOGISTIC SUPPORT INDICATORS (MOVING AVERAGE) FOR AN/SPS-40B



SOURCE: AN/SPS-40, 40A, 40B, 40C, 40D IMPROVEMENT PROGRAM, DART PROGRAM REPORT PERIOD
ENDING MAY 1980, DART-SPS 40 - FY803, NAVAL SEA SYSTEMS COMMAND.

FIGURE 4-3 OPERATIONAL AVAILABILITY (A₀) OF AN/SPS-40B RADAR SET



SOURCE: SAME AS FIGURE 4-2

TABLE 4-1. DEFINITIONS OF LOGISTICS SUPPORT INDICATORS

SYMBOL	DEFINITION																											
A_a	Achieved availability (Navy term for what is commonly referred to as inherent availability), defined by: $A_a = \frac{MTBCM}{MTBCM + MTTR}$																											
A_o	Operational availability, defined by: $A_o = \frac{MTBCM}{MTBCM + MDT}$																											
AMT	Average maintenance time (days). For casualties whose repair has been reported by a CASCOR message, AMT is computed as the number of days the equipment was down due to maintenance. This time period includes active repair time as well as administrative delays and awaiting technical assistance.																											
APD	Average parts delay time (days). For casualties with a CASCOR this is the number of days the equipment was down while awaiting parts as indicated in the CASCOR message.																											
CAS	Number of CASREPs submitted for an equipment.																											
CAS(C-x)	Number of CASREPs for an equipment reducing material readiness to condition C-x.																											
CMA	Corrective maintenance action. Any maintenance action reported in the MDCS system is defined as corrective if it meets the following conditions for status code <u>and</u> action taken code or deferral code: <table><tr><th>Status Code</th><th>Action Taken Code</th><th>Deferral Code</th></tr><tr><td>1. Operational</td><td>1. Maintenance action completed; parts drawn from supply</td><td>1. Due to ship's force work backlog/operational priority</td></tr><tr><td>2. Non-operational</td><td>2. Maintenance action completed; parts not drawn from supply</td><td>2. Lack of material</td></tr><tr><td>3. Reduced capability</td><td>3. Maintenance action completed; no parts required</td><td>3. No formal training for this equipment</td></tr><tr><td></td><td></td><td>4. Formal training inadequate for this equipment</td></tr><tr><td></td><td></td><td>5. Inadequate school/practical training</td></tr><tr><td></td><td></td><td>6. Lack of facilities/capabilities</td></tr><tr><td></td><td></td><td>7. Not authorized for ship's force accomplishment</td></tr><tr><td></td><td></td><td>8. Lack of technical documentation</td></tr></table>	Status Code	Action Taken Code	Deferral Code	1. Operational	1. Maintenance action completed; parts drawn from supply	1. Due to ship's force work backlog/operational priority	2. Non-operational	2. Maintenance action completed; parts not drawn from supply	2. Lack of material	3. Reduced capability	3. Maintenance action completed; no parts required	3. No formal training for this equipment			4. Formal training inadequate for this equipment			5. Inadequate school/practical training			6. Lack of facilities/capabilities			7. Not authorized for ship's force accomplishment			8. Lack of technical documentation
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		6. Lack of facilities/capabilities																										
		7. Not authorized for ship's force accomplishment																										
		8. Lack of technical documentation																										
MCI	Material condition index. Composite index reflecting the number of CASREPs reported for a given equipment within a given time period, the severity of the casualties and the average time required to correct the casualties: $MCI = \{0.1 \text{ CAS}(C-2) + 0.5 \text{ CAS}(C-3) + \text{CAS}(C-4)\} \times \text{ART}$ (For analytic applications, the MCI is normalized by dividing the above expression by the number of equipments in the reporting population).																											
MCMH	Mean corrective manhours. This is the average manhours per corrective maintenance action for a specific equipment as reported by the MDCS over a given time period: $MCMH = \frac{\text{total corrective manhours reported}}{\text{total CMAs with manhours}}$																											
MDT	Mean downtime (hours). The Navy uses the following definition for determining MDT for an equipment, based on the assumption that on the average 1.5 technicians work simultaneously on each CMA: $MDT = \frac{MCMH}{1.5} + (\% \text{ CMA deferrals for parts}) \times \text{NORS}$ (Note that by the nature of this definition the Navy's MDT statistics are incomplete: not included are CMA deferrals for technical assistance or due to operational priorities).																											
MTBCM	Mean time between corrective maintenance actions. For a given equipment, this indicator is defined for a given time period as follows: $MTBCM = \frac{\text{total accumulated operating hours}}{\text{total reported CMAs}}$ (Note that in the absence of equipment operating time meters, this indicator is essentially based on calendar time, not operating hours. The computational logic used by the various ISEAs is not consistent: some use number of days in the reporting period adjusted only for planned availabilities; other use empirical factors differentiating between at-sea and in-port time. Only under formal technical evaluations are equipment operating hours tracked in order to derive mean-time-between-failure (MTBF) statistics.)																											
MTTR	Mean time to repair, defined as follows: $MTTR = \frac{MCMH}{1.5}$ (On the average 1.5 technicians are assumed to perform CMAs)																											
NORS	Not operationally ready due to supply (days). This indicator is determined from supply data via MDCS. Due to different reporting procedure, NORS is not exactly (but approximately) equal to APD.																											

accompanied by an ET, trained (NEC 1516) and experienced (1st class petty officer) in SPS-40B maintenance to help effect repairs. Evaluation of this test showed that mean downtime was reduced by 40 percent, A_0 increased from 0.58 to 0.67, but NORS days remained the same. Importantly, only 6 parts from the PUP kit were actually used during the test, suggesting that the expert technician was the major reason for the improved availability.

Not until a survey was conducted from March through May 1978 aboard selected ships were the true dimensions of the SPS-40B, C, D problems identified. The survey was requested by CINCLANTFLT by message to CNM. NAVSEA was directed to organize a Ship Assist Team (SAT) to visit selected ships to identify root causes of the radar's operational availability shortcomings and determine if ongoing DART actions were correcting known problems. The team, composed of people from NAVSEA, NAVSEC (Norfolk and Mechanicsburg Divisions), MOTU TWO, FLETRACENLANT and NORDEN Systems, Inc. (the prime contractor on the SPS-40 series contracts), visited four ships and identified numerous personnel and training-related shortcomings. An excerpt of their summary report is provided in Table 4-2.

An even more comprehensive analysis was conducted by a special task force created by COMNAVSURFLANT, ACS/Readiness and Training, to examine readiness problems experienced with several radars, including the AN/SPS-40 series, and fire control systems, including the Mk 86 GFCS. This task force compiled the information provided by many other studies and sources (OPTEVFOR, INSURV and LRG reports, project managers, contractor studies, SAT reports, Fleet Analysis Center and Commanding Officer Narrative reports) and conducted some surveys of its own (Harris, 1979). One survey examined the quality of training for SPS/40 operators/maintainers. It found that after "A" school, Basic Electronics school, and "C" school (NEC 1516), the graduate needed at least

TABLE 4-2. SUMMARY OF SAT REPORT ON AN/SPS-40B/C/D PROBLEMS

KEY ¹	PROBLEM	CAUSE	RECOMMENDATION
TRA	Technicians performing maintenance cause damage to Unit 4.	"C" school training does not include mechanical disassembly/reassembly of high-power amplifier.	NAVSEA proceed with procurement of two Unit 4s for installation at Training Commands. CNET modify training course curriculum. NAVSEA/SPCC provide training sites with operable PA tubes.
	Technicians cannot properly align the receiver.	Training is performed with radar in dummy load, no live targets.	CNET obtain authorization to radiate the radars at the schools. CNET provide additional MTI/Receiver training by use of film, videotape.
	Technicians are not requesting the correct repair parts.	ETs are not familiar with supply support documentation nor the SMR codes defining the maintenance concept.	CNET expand BEE, A or C school curriculum to include supply support procedures and documentation. TYCOMs establish procedures to verify ships have latest documentation aboard.
LOG	Large percentage of repair parts needed is not available when needed. Percent of parts not on board when demanded is 66% (FY73-77 average). Percent of part demands on allowance but not on board is 17% (FY73-77 average).	Fifty percent requisitions outstanding were open in excess of 120 days. Range of APL inadequate. Ships unaware of new APL's improper inventory records.	NAVMAT review requisition process. SPCC stock repair parts at central location at each coast and forward positions outside CONUS. NAVSEA institute LOGSAT with annual shipboard inventory. TYCOM direct inventory checks and reporting procedure on requisitions open over 30 days. NAVSEA ensure that current check teams (CSRT, CSRR, SQT) place emphasis on inventory records and report deficiencies.
	Some replacement parts, stocked as RFI, are found unusable.	Parts are procured without adequate vendor testing. Critical parts are not system-tested prior to stocking.	NAVSEA identify critical repair parts and recommend testing procedures. SPCC implement through procurement actions.
	Supply system does not respond when items are found NRFI.	Ships do not issue defective material reports (DMR).	TYCOM ensure ships to follow existing DMR procedures.
PMS	Ship's water cooling system is major cause of CASREPs.	Maintenance of cooling system is a split responsibility so that it gets little, if any, preventive maintenance.	NAVSEA/NAVSEC revise MRCs to include water cooling system and division responsibility. TYCOM ensure uniform procedures for PM/CM of the water cooling system.
	Moisture in transmission line and RF cavities causes failures.	There is no requirement to keep the transmission line pressurized radar inoperative.	NAVSEA direct ISEA to issue appropriate EIB.
	Improper performance of preventive maintenance of the radar set.	Operational schedules do not allow adequate radar downtime for preventive maintenance. PMS for radar receives low priority.	TYCOM revise shipboard procedures so that ET time is used for active equipment maintenance vice diversions.
P	SPS-40 technician billets are unfilled or filled with incorrect NEC.	Insufficient ETs available to fill all billets.	BUPERS ensure all SPS-40 billets are filled with properly trained personnel.
	Some SPS-40 "C" school quotas are being filled with ETs who have no radar experience.	"C" school quotas are open to both ETN and ETR ratings.	BUPERS ensure SPS-40 quotas at "C" school are filled with ETR.
	ETs spend large portion of available time aboard ship on non-maintenance activities.	ETs are required to fill out requisition form prior to submission to Supply Department. Also required to perform bearer pickup of requisitions involving excessive waiting times at supply depots.	TYCOM revise shipboard procedure for requisitioning parts, letting ET provide part identification and quantity required, and submit to complete the form. TYCOM ensure other shipboard personnel perform bearer pickup.
DOC	Shipboard ET does not have latest documentation.	No procedure exists to ensure that documentation forwarded to ship is received by appropriate personnel.	Ship visit teams place more emphasis on review/correction of supply documentation.
	Inaccuracies exist in identifying repair parts when cross-referencing between different parts documentations.	APLs are issued upon demand and are generated from a continuously updated data base. Thus, APLs may differ from ship to ship and do not match the parts list in the Technical Manual as the latter reflects the original product baseline and is soon out of date.	SPCC add National Identification Index Number (NIIN) to Section 3 of the APL and provide hard copy to all users. SPCC develop a new Section C of the APL ordered by NIIN for limited distribution to technical community to facilitate cross-referencing manufacturer's parts number (MPN), reference symbol number (RSN) and NIIN.

TABLE 4-2. SUMMARY OF SAT REPORT ON AN/SPS-40B/C/D PROBLEMS
(Continued)

KEY ¹		CAUSE	RECOMMENDATION
TE	General-purpose electronic test equipment is frequently unavailable when required.	Test equipment turned in for repair or calibration has a long turnaround time. An incorrect utilization frequency has been assigned to SPS-40 GPETE. Test equipment storage is remote from radar room.	NAVEX institute test equipment turnaround program with direct replacement. NAVSEA review GPETE allowance procedures. NAVSEC provide test equipment storage area in or near radar room for ET.
	Sweep oscillator calibration involves excessive delays.	Calibration specification was developed to satisfy both shipboard and depot maintenance requirements. This spec is unnecessarily stringent for shipboard test equipment used over a more limited frequency band.	NAVSEA relax specifications for calibration of shipboard sweep oscillators to include only frequency band normally used aboard ship.
SPT	Inadequate manning of MOTU prevents conduct of OJT and limits technical assistance provided.	Lack of sufficient billets.	NAVPERs increase number of civilian and military billets assigned to MOTU for SPS-40 support.
	Back-up support systems are underutilized (on-call field engineering, ISEA, cannibalization, direct purchase of factory stock).	Shipboard personnel do not request assistance until the twelfth hour.	TYCOM direct ships to request outside help for any CASREP after 4 weeks. NAVSEA/TYCOM develop procedures for providing technical assistance. NAVSEA organize SAT to provide assistance to ships nominated by TYCOM.
	Known equipment improvements take too long to implement.	After requirement for field change is identified, delays are caused by configuration control, identification of funds, first article testing, software development, installation and contract lead times.	OPNAV/NAVSEA establish level funded line item for procurement of minor RAM improvements for major equipment.
	Production PA tubes are not compatible with all production radars.	Transmitter design not adaptable enough to compensate for wide range of electrical characteristics of production PA tubes.	NAVSEA develop modification to provide transmitter capability to varying electrical characteristics of PA tubes.
	Condensation causes breakdown and corrosion problems in high voltage areas.	Installation procedure does not require installation of a low water temperature cut-off. Excessive low temperature causes condensation to form, resulting in arcing and failure.	NAVSEA procure field change for a low water temperature cut-off in the interlock chain. NAVSEC develop ECP for this change.
	Maintainability is hampered by poor installation practices.	Installations are not in conformance with ICDs and EIBs.	NAVSEA prepare installation planning documents and ensure all ships follow these plans. NAVSEA/NAVSEC verify installations.
	Waterfront repair activities and tenders do not have capability on hand to repair coaxial wave guide.	No provision was made to have on hand sections of coaxial wave, guide, flanges and qualified welders.	TYCOM/NAVSEA establish coaxial wave guide repair capability on waterfront and tenders, and equip them with required material and skills.

SOURCE: NAVSEA summary of Ship Assist Team reports forwarded to CMM, 22 January 1979.

¹ Key: TRA - training
LOG - logistic (supply) support
PMS - planned maintenance system
P - personnel
DOC - documentation
TE - test equipment
SPT - technical support

six months' OJT to become a capable technician. FTC instructors felt the apprentice could gain this OJT on his own if he were given time to study the manuals and equipment and perform PMS, but, in practice, this opportunity is not given because of collateral duties. School training was deemed adequate to qualify the graduate to perform 35 maintenance tasks, inadequate but sufficient for learning all tasks from shipboard OJT, inadequate and insufficient for learning 5 tasks through OJT. The latter include:

- remove, replace modules or cards in radar transmitters (unit 4) (lack of hands-on training in "C" school)
- dry air and chilled water systems (taught to another rating but required for SPS-40B maintenance)
- Moving Target Indicator (MTI) alignment (only a 15-hour module in school, even though the timing adjustment of MTI circuitry is critical for proper operation of the system especially to counteract ECM)
- antenna maintenance
- test/inspect amplifiers

The report concludes that additional class training is required, possibly to be provided by MOTU. The report also attributes much of the supply problem to "human errors" causing 50 percent higher demands than predicted based on reliability computations. Human errors are attributed to the following factors: a design so complex that "technicians are rarely able to understand maintenance procedures"; inadequate troubleshooting procedures in the manuals; unavailability of test equipment due to excessive turnaround times for calibration; defective parts in the supply system; operational requirements which cause technicians to attempt PCB repairs using unauthorized components (cannibalized from throwaway modules or purchased from "Radio Shack"); and environmental problems (chilled water/dry air/air conditioning).

The above excursion into logistic support areas other than manpower, personnel, and training was necessary to illustrate how an availability problem first thought to be related to supply support was actually caused, to

a large extent, by personnel and training-related deficiencies. Returning to the DD-963, Table 4-3 compares the manning requirement, authorization, and on-board status (June 1980) for the SPS-40B operator/maintainer (NEC 1516). Bearing in mind what was previously said about the relationship of task performance and experience, it is clear that the single technician aboard the DD-963, dependent on extensive OJT from an unavailable expert, will have difficulty attaining the requisite skills by himself. The situation clearly invites maintenance problems.

TABLE 4-3. AN/SPS-40B MANNING

Rate/Rating/NEC	Class SMD	MPA	DD-963 NMP	COB	MPA	DD-992 NMP	COB
ET1 NEC 1516	1	1			1	1	1
ET2 NEC 1516	1	1	1	1	2	1	1
TOTAL	2	2	1	1	3	2	2

As an illustration of the games which can be played with the personnel system, Table 4-3 includes the manning requirement and on-board status for the SPS-40B aboard the final ship of the class, the DD-992 (USS FLETCHER). Recognizing the inability of a relatively inexperienced ET2 to maintain the SPS-40B all by himself, the ship submitted a MFA change request offering in-grade compensation in a rating with an inventory in excess of requirements Navy-wide. (Requests providing compensation are normally approved). With the MPA for NEC 1516 increased to 3, the NMP increased to 2, and the ship has now two ET 1516s aboard vice the DD-963 one. (The statistical sample was too small to derive a valid measure of the impact this had on SPS-40B availability aboard DD-992 vis-a-vis DD-963).

MK86 GUN FIRE CONTROL SYSTEM

The Mk86 GFCS is a lightweight (15,000 lbs.), digital weapon control system providing naval gunfire control against surface, air, and shore targets. The system is capable of tracking simultaneously four surface targets, two shore targets, and one air target. The Mod 3 installed aboard the DD-963 can simultaneously direct the fire of two 5" guns against any two tracked targets.

The system comprises 24 major units, including a control officer's console (COC); two gun control consoles (GCC); a digital computer; two track-while-scan radars, the AN/SPG-60 (air targets) and the AN/SPQ-9 (surface and low-flying-airborne targets); two remote optical sights (closed-circuit TV), one used for acquisition and tracking of visible targets, the other as backup or as target designation transmitter for counter-battery fire missions; and 16 other units. The computer (a Mk152 general-purpose, stored-program device) performs ballistic computations and generates gun orders. The system provides for automated dead reckoning during grid fire (with target out of view of both radar and optics): target and own ship coordinates entered at the gun control consoles into the computer are automatically updated from the ship's compass and log or from radar tracking of a beacon or navigational reference. The control officer's console displays all search radar returns. Using this display, the control officer evaluates potential threats and selects targets for automatic tracking. After target track has been established, he assigns a specific target to either gun control console. The system exchanges analog and digital data with external sources, such as NTDS, and can accept data from other shipboard sensors.

The Mod 3 installed aboard the DD-963 (and CGN-36) class ships will be upgraded to a Mod 10. Modifications include the AN/UYK-10 computer system,

redesigned weapon control consoles (in lieu of the GCC) to reduce operator task complexity, and installation of an electro-optical sensor system (SEAFIRE) replacing one optical sight (actually done by ORDALT, not part of Mod 10 upgrade). The SEAFIRE is a major subsystem, planned for fleet introduction in fiscal 1983. It provides range data for surface targets, a second tracking channel for air and shore targets by daylight television and a thermal imaging system, and a laser range finder/illuminator for terminally guided laser ordnance.

The original prototype system (MK86 Mod 0) underwent technical evaluation in 1966. The production prototype (Mod 2) completed technical and functional evaluation in 1971. OPEVAL of the production system (Mod 3) was completed in October 1972. OPTEVFOR recommended against procurement of the system, but CNO granted approval for service use in January 1973, conditional upon certain production model changes. Mod 3 was installed aboard the DD-963 class. Other models evolved with different capabilities and are installed aboard other ship classes (Mods 4, 5, 8 and 9). The Mk86 requirements specifications included a 100 hours MTBF, a two hours MTTR (goal) and an A_0 of 0.90.

The original maintenance concept was the traditional on-board (organizational-level) module repair through replacement of failed components (bit and piece parts like integrated circuits, resistors, etc.), and intermediate-level backup by tender or IMA. When the Mk86 was fielded, this maintenance concept was changed to one requiring module replacement (no module repair) at the organizational level and depot-level module repair. No intermediate-level repair capability was planned.

The poor operational availability of the system was first attributed to low reliability of certain units and inadequate supply support. Two additional problems were the need to revise the operational capability parameters

(the Mk86 was designed to receive signals from a 3D air search radar, while the AN/SPS-40 is a 2D radar), and the tendency of the system to lock on clouds. The latter problem was aggravated by the system's "break lock" feature, which caused the system to return to its original target acquisition point to recommence search, rather than to the last known target position. Corrective action was taken by the equipment manager (NAVSEA 62Y22) and the ISEA (NSWES). A total of eight engineering change proposals (ECPs) and ORDALTS were approved in January 1977, with fleet introduction October 1979. Expanded APLs were completed in April 1977. NAVSEA informed the fleet about these actions via message (Mk86 Advisory No. 1, January 1977, reviewing the problems and actions planned; Advisory No. 2, March 1977, pointing out the delays involved in getting the additional spares authorized onboard and emphasizing the damage inflicted by crews attempting module repair vice replacement.) Also, a long-term program was established to improve the system's foul weather performance.

CNM conducted a logistics audit of the system in May 1978 and identified deficiencies in training (especially maintenance skills), technical manuals, and supply support. NAVSEA was directed to correct these deficiencies. During 1978 and 1979, operational availability of the system remained unacceptable, well below the goal of 0.90. Data collected by the ISEA for January-September 1979 (23 systems with 110,304 hours active (energized) time) are shown in Table 4-4 below. The data suggest that the maximum A_0 attainable for this system is about 0.70 after significant reliability improvements in the two radars.

TABLE 4-4. LOGISTIC SUPPORT INDICATORS FOR Mk86 GFCS

Subsystem	MTBF ¹	MTTR	MLDT ²	A _o	A _i ³
Data Group	1,435	9.4	194	0.98	0.98
Display Group	735	4.5	400	0.98	0.98
Optical Group	1,552	6.0	787	0.92	0.99
AN/SPG-60	532	5.0	374	0.82	0.96
AN/SPQ-9A	398	4.0	429	0.83	0.97
Mk86 SYSTEM	142	5.0	424	0.57	0.89

¹Based on energized time and failures reported.

²The system average of 424 hours mean logistic delay time compares with a Navy-wide average of approximately 130 hours.

³Equals A_o (defined in Table 4-1) except for no logistics delay time; i.e. assuming immediate supply of spares needed for repair.

Findings of the COMANVSURFLANT Task Force referred to earlier in the SPS-40 section (Harris, 1979), included the following:

- Service School Command at Great Lakes has a Mk86 installation for maintenance training but it is plagued with downtime. It is the only installation in the Navy for maintenance training and is used on a double-shift basis. Funds for additional Mod 5 trainers for fiscal 1977-78 were deferred.
- Technical support organizations (MOTU, NAVSEACEN, shipyards) are short Mk86 technicians. Additional MOTU billets were authorized in fiscal 1978, but were not filled until fiscal 1980, and then only partially.
- The new APLs (adding 45 items to the original authorized stockage) were included in the COSALs for new ships, but funding limitations did not allow distribution of these APLs in current operational ships until fiscal 1978. Some ships still do not have the new APL due to lack of knowledge of supply system procedures.
- Parts shortages and requisition delay times force technicians to attempt module repair in conflict with the new maintenance concept. This capability is obtained through attending the "2M" (micro miniature repair) course. Ships with 2M graduates are authorized acquisition of a PACE soldering kit containing the tools required to perform (PCB) repairs, but the supply system does not support this concept so

that technicians have to obtain needed piece parts either by cannibalizing faulty PCBs (throwaways or modules not returned to depot) or from outside sources ("Radio Shack"). Also, ships preparing to deploy often correct outstanding CASREPs by cannibalizing the Mk86 system aboard other ships.

- About 50 percent of the modules arriving at depot level are actually ready for issue. This indicates a lack of troubleshooting capability by the ship's force, inadequacies in test equipment and technical documentation, and a need for a module screening capability.

Interviews conducted by this task force to assess the quality of training received by technicians elicited the following responses:

- No hands-on troubleshooting nor system alignment instruction is given.
- Most casualties taught do not require test equipment; they are typically limited to fault locations such as "bad card" or "disconnected plug".
- Instruction does not include PMS.
- OJT aboard ship is limited to what technicians can manage by themselves or can get from field engineers.

In September 1979, COMNAVSURFPAC, in a message to CINCPACFLT, reiterated the Mk86 problems and recommended that CNM conduct a review of the status of corrective actions. The CNM Logistics Review Group conducted another audit in February 1980, with TYCOM representatives invited to ensure fleet input and feedback. The focus was on adequacy of technician training, adequacy of maintenance procedures, test equipment and documentation, adequacy of shore-based support in training and technical assistance, equipment RAM characteristics, and supply support issues, including requisition lead times and depth/range of allowance lists.

In its audit summary report of March 1980, the LRG recommended that certification of ILS planning/implementation be withheld pending resolution of the deficiencies noted. NAVSEA revised the NTP for the Mk86; let contracts for development of improved technical manuals, including a task-oriented

maintenance manual outlining systematic procedures for functional troubleshooting, fault isolation, and alignment, utilizing one-function diagrams, logic tree troubleshooting aids and diagnostic computer tape; and let a contract for development of maintenance courses for the new Mods 8 and 10. The latter required application of more detailed procedures prescribed in NAVSEA OD45519 for submarine training systems. It emphasizes front-end analysis in training development to result in task-oriented training. This contract also included a conversion course covering the differences between Mod 3 (currently aboard DD-963) and Mod 10 (the future upgrade planned for DD-963). The above actions were communicated by NAVSEA to the fleet via Mk86 Advisory No. 6, April 1980. (This Naval Speedletter also reiterated previous advisories regarding the counterproductive results of ship's force attempting module repairs instead of replacements.) The new troubleshooting manuals reached the fleet in the fall of 1980. A new category of manuals was also developed ("operational support guides") identifying to the fleet the logistic support programs and resources available to support the Mk86.

The NTP Conference took place in May 1980. The updated NTP identifies a number of action items (which are still open) with respect to Condition III manning, upgraded training requirements when converting to Mod 10, intermediate maintenance level tasks and associated training requirements. The document identifies a total of 20 technical manuals required for operation and maintenance of the Mod 3 system (written at 9th grade reading level), excluding the alignment manuals and operational support guide referred to earlier.

The Mk86 Mod 3 course at Great Lakes is 32 weeks, followed by a 13-week computer course of digital basic training and Mk152 computer training. Graduates then go to the fleet combat training center, Atlantic (FCTCL) for one

week of orientation and one week of operator training using the Mod 1 prototype system. (In 1984, this system will be replaced by a team/operator trainer). Aboard ship, they receive further NGFS training from mobile team training instructors. To qualify as operators, personnel must meet the requirements of the Personnel Qualification Standard which covers operation of the GCC, COC, Mk152 computer, target designation transmitter, modes of operation, fundamentals of radio and telephone communication, safety, and front panel adjustments. (No PQS has been developed for maintenance tasks).

Table 4-5 compares the manning requirement, authorization, and on-board status (June 1980) for the Mk86 GFCS operator/maintainer (NEC 1125) aboard the DD-963. The table shows that the personnel system is providing good support in spite of the Navy-wide shortage of FTGs and current lack of training capacity (compared to replacement requirements) for this NEC. Any lack of maintenance capability aboard ship is due to training deficiencies, not to personnel shortages.

TABLE 4-5. Mk86 GFCS MANNING ABOARD DD-963

Rate/Rating/NEC	SMD (=NTP)	DD-963		
		MPA	NMP	COB
FTGC 1125	1	1	1	1**
FTG1 1125	0	0	0	1
FTG2 1125	1	1	1	4**
FTG3 1125	2	3*	2	0
FTGSN	1	0	1	1
TOTAL	5	5*	5	7

*includes 1 billet without NEC

**includes 1 person without proper NEC

SUMMARY

The two weapons system examples serve to illustrate the difficulty of and delay in correcting personnel and training deficiencies when equipments are

fielded without sufficient attention to ILS planning and implementation. Both were first fielded in the early seventies, but neither achieved its inherent capabilities. Lack of adequate training was one of the causes; this has now been identified and is being corrected. In both cases, the delay in upgrading maintenance training amounts to approximately eight years.

The examples also illustrate that the indicators collected by the cognizant System Command with support of the ISEA may identify the existence of a problem, but are insufficient to diagnose it. The focus of the equipment managers is primarily on the hardware, with little attention paid to personnel and training factors. Recognition of the latter as contributing causes is dependent on fleet input and on-site surveys. CNET does not possess a feedback channel for assessing the quality of the school training graduates it delivers to the fleet. There are no PQS for maintenance skills.

The examples also illustrate the importance of top-level management attention when required corrective actions cross traditional functional boundaries. In the case of the AN/SPS-40B, it took the DART program (supplemented by on-site surveys) to confirm the existence of maintenance training deficiencies and to emphasize the need for providing the training equipment required to correct this deficiency. In the case of the Mk86 GFCS, it was the DART program which finally caused necessary improvements in training and job performance aids.

5. SYNOPSIS, CONCLUSIONS AND RECOMMENDATIONS

Ideally, the goal of a ship acquisition program should be to achieve operational capability (readiness and wartime sustainability) soon after each ship's post-shakedown availability. The DD-963 case study documented in the preceding chapters illustrates the types of problems involved in reaching that goal. Only now, with the first ship of the class in overhaul five years after commissioning, do the major adjustments in manpower requirements seem to be over and the requisite changes in training courses have been identified.

Some of the reasons for this delay are due to the DD-963 acquisition strategy, but others suggest that the Navy's procedures in the manpower, personnel, and training areas could be improved. This chapter recapitulates the lessons learned from this case study and recommends a number of changes in current policies pertaining to the planning and validation of ship manning requirements, assessment of individual skill training deficiencies, and evaluation of factors contributing to operational availability shortfalls.

WHY MANNING REQUIREMENTS CHANGE

During the first five years of its operational life, the DD-963's enlisted manning requirements increased from 224 to 295, a growth of 32 percent. (Including installation of OUTBOARD, the enlisted personnel requirement estimate is now 307, a growth of 37 percent.) The 224 figure was the PSMD estimate at delivery of the ship and remained constant through final contract trials. The 295 figure is the current draft SMD, as yet unapproved by OP-01. It is a consensus estimate of the acceptable manning level for the current ship configuration; it does not reflect the manning impact of future payload growth (during or subsequent to first overhaul); and it is predicated upon the success of a facility maintenance improvement

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This pattern of manning growth was similar to that experienced in other surface ship acquisition programs initiated in the sixties (Borrelli et al., 1979). The effect of the TPP acquisition strategy was only to increase manning requirements during the ship's early operational years. Traditional acquisition programs have also experienced manning increases during the developmental phases.

The reasons for the growth in manning requirements since final contract trials were numerous. Those peculiar to the DD-963 were the following:

- contractual ceiling on manning requirements for the baseline configured ship
- planned deferral of installation of much of the payload to post-delivery RAVs, with associated manning impact not included until after FCT

Reasons in common with other ship acquisition programs were:

- addition of watchstations by the fleet (apart from added payload)
- growth in PM/CM requirements (apart from added payload)
- overly optimistic estimates of FM workload
- growth in OUS workload, both due to underestimates and induced by manning increases for other workload categories

Table 5-1 compares the relative impact of each cause, showing that equipment additions and increases in watchstanding requirements explain 60 percent of the total growth in DD-963 manning.

CONCLUSION #1: The 32 percent ship manning growth over the first five operational years was caused by: shipboard installation of planned, additional payload; operational experience with the ship resulting in additional watchstations; growth in the planned maintenance system workload over the intervening years (only in part attributable to added payload); non-performance of manpower-saving design features (e.g. automated sensor system weatherdeck and bulkhead coatings); inability of the crew to perform all preventive and corrective maintenance required and still perform facility maintenance; and more administrative/support workload than had been estimated.

TABLE 5-1. CAUSE-EFFECT RELATIONSHIPS FOR DD-963 MANNING CHANGES

Impact	Equipment Additions ¹	Operational Requirements ²	Underestimates in:		
			PM/CM	OUS	FM ³
Manning impact as percent of final PSMD (224)	12%	11%	6%	5%	4%
Relative contribution to manning growth (83 = 100%)	31%	29%	17%	13%	10%

¹Includes both operator and maintenance manning requirements for added equipments.

²Net additional watchstanders required in Condition III.

³FM workload is well in excess of available manhours but FM improvement programs are planned to reduce FM workload.

HOW MANNING REQUIREMENTS CHANGE

Identifying the direct reasons for ship manning increases is one thing; explaining why this happens on every ship acquisition program in the Navy requires an understanding of what a PSMD really represents. In the case of the DD-963, the final PSMD for the Navy-approved baseline configuration was a shipbuilder's document delivered under the terms of the TPP contract. The SHAPM was not responsible for revising this or previous documents until after final contract trials had been completed (see page 1-12). He could not do so in view of the contractual manning ceiling, even though the PSMD was clearly based on assumptions known to be optimistic (see page 2-12).

Under today's acquisition policies, not much has really changed with regard to PSMD logic. While the SHAPM (vice the TPP contractor) is still responsible for the PSMD, the incentives are for him to err on the downside.

Fleet input is very limited until after operational experience has been accumulated. Workloads such as PM are limited to what has been documented to date, even though the PMS for a new ship follows a typical growth curve as it evolves over time. In other words, if the DD-963 had been developed under today's acquisition policies with a manning goal in lieu of a contractual ceiling, we believe that the first PSMD might not have been much different, though the final PSMD would have included some of the manning growth.

The key point lies in recognizing what a PSMD represents: it is a point estimate in an evolving manpower requirements determination process. It is not designed to predict mature ship manning requirements. The latter, based on empirical data for surface combatant ships, invariably show increases of 20 to 30 percent over initial PSMDs.

CONCLUSION #2: By its very nature, the PSMD is not predictive of mature ship manning requirements. It is a point estimate applicable to a particular ship configuration. It reflects the particular viewpoints and constraints of the material developer and does not reflect operational experience with the ship. It always underestimates the final SMD for the ship since it does not take into account planned or unplanned configuration changes which add payload; does not compensate for lags in documented workload (PMS); and is based on optimistic estimates of other workload categories.

ESTIMATING MATURE SHIP MANNING REQUIREMENTS

The procedures prescribed in OPNAV 10P-23 provide a logical approach to the development of a PSMD, but the resulting PSMD invariably underestimates mature ship manning requirements. Obviously, the need for, and extent of, changes in manning requirements could be reduced by transforming the PSMD into something more predictive of mature ship manning requirements. This could be done by including the manning impact of payload additions planned for ship-board installation in the next five years and growth margins for the baseline estimates of the various workload categories by work center. These growth

margins could be based on empirical data collected by ship category and adjusted for the particular circumstances pertaining to each ship.

For example, the PMS-documented workload for the DD-963 doubled in five years, but only a small part was attributable to the added payload. One relevant fact was that most equipments were not covered by existing MIPs (though, expressed in manhours, a large portion was covered). The Guided Missile Frigate (FFG-7) program had a much higher proportion covered by existing MIPs (both equipments and manhours) in the PSMD and showed a much lower growth in PMS.

With regard to FM, use of a consistent estimation methodology (as, for example, provided by PATAO's FM model documented in Betaque et al., 1978) would lower the need for a growth or error margin. For the DD-963, the FM estimate was clearly influenced by the assumption of workload-reducing coatings which were not actually implemented or were provided without meeting the fleet's standards of cleanliness, so that periodic painting was still required. (The contract did not specify the coatings, just that FM should be minimal).

CONCLUSION #3: The need for changes in manning requirements can be reduced by including error or growth margins in the PSMD for the baseline estimates of each workload category based on historical experience, and by including the manning impact of planned payload additions.

PROPER USE OF DESIGN MARGINS

Ship design engineers recognize the following types of margins (Gale, 1975):

- Design and construction margins: margins provided in the early phases of a new design, intended to be consumed or deleted if not consumed prior to ship delivery. These margins are intended to protect against: prediction errors, anticipated changes in top-level requirements as the design proceeds, and unknowns at the time predictions have to be made.
- Assurance margins: margins provided to increase the probability that a specified performance level can be attained/sustained under improbable adverse conditions.

- Future growth margins: margins provided for modifications and equipment additions during the lifetime of the ship. These margins are normally subdivided into two categories: (1) those specified by OPNAV, whose consumption is controlled by OPNAV, and (2) those provided by ship design engineers to account for "service life growth", not formally controlled by OPNAV.

OPNAVINST 9330.6 defines the "accommodations margin" which must be included in new ship designs, i.e. the amount by which the accommodations provided in the ship must exceed manning requirements. This growth margin represents an attempt to reduce life cycle costs by anticipating future modernizations of payload during the lifetime of the ship.

In the case of the DD-963, the contract formally included a 10 percent accommodation margin in accordance with the letter of this OPNAV policy (manning requirements ceiling: 247 ship's force plus 19 aviation detachment; accommodations specification: 296). But much of the payload had been deferred from the contract for installation during post-delivery RAVs, primarily because of GFE not yet approved for service use. As a result, the accommodation margin was consumed immediately after final contract trials when the deferred equipments were installed, leaving no margin for future growth. Due to the growth subsequently experienced, and in view of further planned equipment growth, 45 enlisted bunks had to be added during first overhaul.

Importantly, during the intervening years, the available accommodations served to defer official recognition of the increase in ship manning requirements. Even today, the only approved Class SMD is for 270 enlisted personnel, even though the consensus estimate for the current configuration is (and has been since July 1979) 295.

CONCLUSION #4: The accommodation margin identified in the DD-963 contract specifications was consumed by the planned payload additions installed immediately after final contract trials. The resulting disappearance of a sufficient growth margin caused a delay in formal approval of the required increase in ship manning. Had the accommodation margin been applied to a manning estimate incorporating planned payload additions and workload growth experience, no ship alterations would have

been necessary for the addition of bunks, and early approval of the draft SMD for 295 would have been likely.

SHIP MANNING VALIDATION

The process by which the Navy validates manning requirements for a new surface combatant ship has little to recommend itself, as demonstrated by this case study. A major change is needed in this process. It is unlikely that an in-port activity sampling study would provide the data necessary to project Condition III (at sea) manning requirements. The OPNAV guide recognizes that activity sampling only measures the work (especially FM and OUS) actually done by the crew, not the work required; it suggests that the study results also should consider other data sources, such as models and experience on similar ships, in an attempt to account for work required but not performed during observation. Looking at the wide variations in study results (see Table 2-2) suggests that NAVMACLANT and NAVMACPAC interpreted the guide differently.

It would seem that the only realistic approach to validating Condition III manning requirements would be to conduct an at-sea evaluation, in accordance with an OPTEVFOR test plan, concurred in by the fleet (CINCLANT/PAC). Even then, attention would have to be paid to the predictable growth of PMS based on empirical data. Parts of the validation could be combined with other evaluations (such as OPPE by the PEB and OPEVALs by OPTEVFOR); parts would remain unchanged (e.g. validation of the documented PMS requirements); and parts would be peculiar to the ship manning validation exercise (FM and OUS workloads).

Under current procedures, the SMD validation is done under the auspices of DCNO(MP&T). There may be a precedent for this, but DoDD 5000.3 directs that personnel requirements for a new weapon system be evaluated by the independent OT&E activity, which in the Navy is OPTEVFOR. In the other Services, the independent OT&E activity does provide an independent evaluation of

the personnel requirements associated with fielding a new system. While DoDD 5000.3 makes an explicit exception for IOT&E for Navy ships (in view of the long design, engineering and construction period required), it does not exempt the Navy from FOT&E:

"After the Milestone III decision during initial production and deployment of the system, the DoD Component's OT&E agency will manage follow-on OT&E(FOT&E), as necessary, to ensure that the initial production items meet operational effectiveness and suitability thresholds and to evaluate system, manpower, and logistic changes to meet mature system readiness and performance goals".

(DoDD 5000.3, December 26, 1979, Section 3, Operational Test and Evaluation, paragraph f); and:

"For all new ship classes, continuing phases of OT&E on the lead ship shall be conducted at sea as early in the acquisition process as possible for specified systems or equipments and, if required, for the full ship to the degree feasible."

(Ditto, Section 5, T&E for major ships of a class, paragraph d)

CONCLUSION #5: The Navy's manpower validation of the DD-963 was inadequate. Its procedure does not lend itself to obtaining a realistic assessment of Condition III manning requirements. The organizational responsibilities for ship manpower validation are not in accord with the spirit of DoDD 5000.3.

MANPOWER AUTHORIZATIONS

The manpower authorization (OPNAV Form 1000/2) for the DD-963, representing the billets funded by the warfare sponsor (OP-03), stayed under the approved manning requirement throughout the first five operational years. After the ship came out of SCN RAV (PSMD Revision #1 increasing OP-01-approved manning requirements to 253), the MPA was first increased to 243 and later (October 1978) to 247. It stayed at the 247 level until March 1980, when it was increased to 270, lagging behind the approved SMD of 270 by 1½ years. The current MPA (effective date October 1980) is still at that level, but adds 12 billets for OUTBOARD to get the training pipeline started. Apparently, Navy

manpower assets are insufficient to meet the consensus estimate of 295 enlisted billet requirements, or the ships are deemed capable of performing their current mission with a ship's force of 270 enlisted personnel.

CONCLUSION #6: The DD-963 manpower authorization has been lower than the officially approved manning requirements throughout the ship's first five operational years.

RELATING MANPOWER AUTHORIZATIONS TO MISSION CAPABILITIES

Apart from the Navy Manpower Requirements System (NMRS), which essentially automates the (P)SMD process outlined in Appendix B, the Navy uses a variety of models to assess the impact of alternative manning for a ship, changes in shipboard procedures, or changes in workload requirements. For example, NAVMMACPAC has developed the Interactive Manpower Alternatives Processor model. Input to the model consists of NMRS data (watchstations, non-operational workloads); using a logic similar to that embedded in NMRS, the model produces ship manning requirements under alternative changes in policy parameters which the user can specify interactively, on-line (e.g. changes in standard work week, allowances, number of sections per watch, rounding rules). A similar model developed with contractor assistance by NAVMACLANT (known as SMAS) assesses the impact of given changes in manning on workload performance.

Both models are accounting-type models, comparing average workloads with average available manhours. Neither is scenario-driven, nor do they relate mission capabilities to ship manning. The only existing model which attempts to do the latter is the SHIP II simulation model developed by NPRDC. The TIGER/Manning model developed by NAVSEC is oriented to subsystems, not a complete ship. Both SHIP II and TIGER have been documented in a previous LMI report (Betaque et al., 1978).

NPRDC was tasked to validate the SHIP II model for the DD-963 class ships. Due to data base problems, this validation effort has so far not been successful.

CONCLUSION #7: The possible impact current manpower authorizations have on the mission capabilities of the ship in a wartime scenario cannot be assessed. The only tool currently available in the Navy for this purpose is the SHIP II simulation model, but this model lacks demonstrated validity, and has so far not been successfully applied to DD-963 manning.

SHARING OF AVAILABLE MANPOWER ASSETS

The current personnel situation in the Navy is characterized by critical shortages in most of the technical ratings. Table 5-2 lists the ratings aboard the DD-963 which are short of Navy-wide requirements, and includes a projection of these shortages showing that the situation may become more critical if current recruiting, attrition, and retention trends continue. (The data shown were developed by NPRDC).

The tool the Navy uses to distribute available manpower is the NMP. This is the outcome of a computerized process which allocates projected inventory to projected authorized billets in priority order. Strategic systems have the top priority and get their full authorization. Recruit training centers, recruiting duty billets, and first-year trials of new ships have second priority. Ships deploying to WESTPAC or the Mediterranean have third priority. After the inventory is allocated by rate/rating to units with the above priorities, the remainder is distributed among all remaining units in direct proportion to their authorizations. Once the NMP is published, it becomes the target of the personnel detailers to fill each unit to its NMP manning level, matching NECs to the best of their ability.

The personnel system has supported the DD-963 manning requirements well, considering the circumstances. The NMP was in excess of the MPA during the early years, but did not keep up with the March 1980 increase in the MPA.

TABLE 5-2. RATINGS ABOARD DD-963 WITH SIGNIFICANT PERSONNEL SHORTAGES

Rating	FY	End strength E-1/3	Availability as % above/below requirements							End strength E-4/9	Rated Requirement
			E-4	E-5	E-6	E-7	E-8	E-9	E-10		
DS	79	330	+22.3	-11.3	-26.3	-10.4	-40.0	-17.7	-7.3	3316	3312
	80	678	+20.6	-14.9	-32.4	-6.3	-26.7	-16.7	-6.9	3322	3493
	81	710	+26.6	-13.4	-36.6	-6.7	+31.0	-16.7	-3.4	3397	3533
	85	762	-31.5	-14.5	-49.3	-6.2	-9.1	-15.3	-0.9	3713	3689
EN	79	5628	-33.1	-13.1	-6.2	-7.7	-9.6	-16.1	-13.9	5310	6321
	80	6061	-21.9	-14.4	-7.1	-6.2	-10.3	-18.4	-14.0	5431	6313
	81	6079	-22.5	-10.3	-6.7	-6.5	-10.7	-16.7	-13.0	5300	6320
	85	6095	-15.7	-3.5	-8.5	-6.1	-9.9	-13.6	-9.3	5815	6414
FI	79	2716	-13.2	-8.3	-6.2	-3.2	-9.3	-13.3	-0.1	1623	1626
	80	3632	-6.6	-6.8	-7.1	-6.4	-10.2	-18.6	-2.1	16035	16386
	81	3585	-12.7	-18.6	-6.8	-6.5	-10.1	-16.9	-3.7	16063	16660
	85	3390	-15.7	-13.3	-8.5	-6.1	-10.1	-14.0	-1.7	16304	16797
FW	79	340	-18.0	-3.9	-28.2	-3.5	-9.3	-18.5	-3.7	1821	1891
	80	635	+17.2	-5.1	-22.9	-6.4	-6.8	-20.0	-3.4	1891	1958
	81	683	+32.9	-17.8	-15.5	-6.2	-10.2	-18.3	-1.5	1934	1963
	85	824	+47.1	-1.6	-9.3	-6.0	-13.6	0.0	-8.4	2113	1951
FTG	79	1012	-21.2	+2.5	-21.3	-2.5			-0.1	3052	3049
	80	1277	+11.5	-11.3	-22.8	-3.5			-6.6	2923	3129
	81	1113	+32.5	-27.7	-31.7	-2.9		N/A	-5.9	3057	3250
	85	1372	+25.2	-6.2	-52.0	-5.7			-5.4	3133	3366
FIM	79	1113	+14.9	+24.2	-41.7	-3.3			-0.7	3235	3233
	80	1132	+12.5	+20.5	-38.4	-5.8			-1.1	3230	3313
	81	1196	+15.4	+5.8	-34.8	-7.7		N/A	-2.2	3192	3263
	85	1243	+18.6	+19.1	-49.6	-3.8			-0.3	3192	3200
GMC	79	3865	+13.1	-7.3	-8.6	-6.7			-2.0	3508	3579
	80	3385	+6.6	-6.8	-7.1	-6.6			-3.0	3452	3561
	81	2725	+13.1	-7.0	-6.7	-6.9		N/A	-1.3	3503	3548
	85	2106	-9.7	-1.5	-8.4	-6.6			-6.2	3389	3614
GMM	79	765	+37.5	-13.3	-56.3	-3.9			-10.5	1105	1223
	80	646	+40.0	-11.5	-54.3	-3.9			-7.4	1156	1248
	81	609	+10.5	-7.3	-40.5	-3.2		N/A	-10.7	1123	1257
	85	599	-2.0	-20.2	-19.3	-4.8			-11.3	1095	1241
GNT	79	784	-37.6	-22.6	-23.2	-1.3	-18.6	+21.4	-24.8	1297	1724
	80	940	-25.6	-19.6	-22.7	-6.4	-16.3	+14.3	-20.5	1363	1715
	81	1010	-20.3	-14.5	-20.5	-6.5	-13.3	-6.3	-16.9	1434	1726
	85	1232	+14.3	-1.5	-9.6	-5.8	-8.7	-12.5	-0.5	1776	1768
GSE	79	179	+49.5	-2.4	-33.3	-31.0			-9.0	242	266
	80	193	+67.2	+44.6	-68.3	-66.7			-0.3	354	353
	81	209	+39.1	+55.1	-67.4	-69.6		N/A	-2.6	415	426
	85	302	+41.9	+54.5	-25.8	-62.9			-11.5	362	304
GSM	79	271	+12.4	-53.6	-5.3	-81.7			-20.5	443	557
	80	257	+33.3	-31.4	-45.3	-46.3			-10.2	519	689
	81	232	-6.7	+6.1	-66.0	-47.8		N/A	-17.4	736	891
	85	354	+39.4	+14.2	-19.7	-49.0			+12.7	1005	892
HT	79	6497	-28.3	-16.5	-20.7	-3.2	-9.2	-19.4	-19.6	7585	9436
	80	6466	-23.7	-23.0	-19.6	-6.4	-10.4	-18.8	-20.0	7642	9546
	81	6277	-29.6	-24.4	-20.0	-6.5	-10.2	-16.2	-22.3	7529	9694
	85	6145	-31.4	-28.8	-11.0	-6.1	-10.1	-13.9	-22.2	7723	9931
IS	79	3048	-22.6	-10.3	-36.5	-3.3	-9.0	-19.4	-20.1	5291	5604
	80	3101	-32.4	-11.1	-31.7	-6.4	-10.5	-18.2	-22.7	5207	6736
	81	3137	-40.9	-18.2	-24.5	-6.5	-10.0	-16.7	-25.8	5068	5833
	85	3194	-37.2	-20.0	-8.5	-6.0	-9.8	-12.9	-21.5	5412	5894
RM	79	5797	-5.1	-7.7	-6.2	-3.1	-9.1	-19.4	-6.2	12367	13398
	80	6351	-1.4	-6.9	-7.1	-6.4	-10.4	-18.5	-3.0	12679	13349
	81	6599	-5.6	-7.0	-6.8	-6.4	-10.1	-16.4	-6.4	12594	13453
	85	6925	+15.0	-1.5	-8.5	-5.1	-10.3	-14.2	-1.9	12625	13373
STG	79	1381	+33.4	-5.3	-14.6	-3.5	-14.1	-7.7	-3.9	3469	3540
	80	1509	-18.0	-16.5	-19.4	-6.4	-10.8	-15.4	-6.8	3386	3556
	81	1283	+29.8	-25.5	-31.5	-6.3	-10.2	-19.2	-6.5	3442	3681
	85	1263	+32.0	-5.7	-55.9	-6.0	-10.2	-12.0	-5.6	3709	3713
TN	79	1561	+43.0	-7.7	-8.2	-8.6	-9.3	-17.1	-19.5	2672	3552
	80	1746	-36.3	-7.3	-7.1	-6.3	-10.0	-18.2	-17.2	2912	3517
	81	1790	-38.5	-7.0	-6.7	-6.4	-11.3	-16.7	-17.6	2923	3543
	85	1853	-22.1	-1.4	-8.4	-6.2	-10.8	-12.9	-11.2	3188	3588

Personnel actually on board were in excess of the NMP in the recent period for which data were available.

From a detailed review of DD-963 manning, it is clear that proportional sharing of manpower shortages (by rate/rating) has some untoward consequences. For example, if a ship is authorized two billets in a critically short rating, its NMP is never going to be more than one; and for one billet authorized, there is no guarantee that the NMP will be one. This can have drastic consequences in terms of maintenance capability aboard the ship as a result of the relationship between performance and experience. If, for example, the authorization for the AN/SPS-40B is for one ET1 and one ET2, and the NMP provides zero ET1 and one ET2, one can anticipate, a priori, maintenance problems.

A better logic in the NMP process could avoid such situations. For example, there are other units requiring, say, five ETs, and depending on the available assets, those units will get their fourth ET before the DD-963 gets its second ET. The requirement for the fourth ET on the former may have less marginal value than the requirement for the second ET on the latter. By recognizing that percent fill of authorization should not be the sole criterion in the NMP logic, a better distribution could be obtained for all.

CONCLUSION #8: Considering the critical, Navy-wide shortages in many of the technical ratings, the personnel system has supported the DD-963 well. There are, however, areas for improvement. Specifically, a non-linear NMP logic for the distribution of rate/rating shortages would result in a more beneficial distribution of manpower Navy-wide.

FEEDBACK SYSTEMS

The numerous feedback systems reviewed clearly show that massive amounts of data are available to identify material problems, including those that may be caused by personnel inadequacies or training shortcomings. To evaluate causes, however, requires an on-site survey, as data through normal channels are inadequate to diagnose a problem.

...the evaluations conducted by the fleet are designed to find and correct any shortcomings. These evaluations are effective in doing what they are designed to do.

The missing link is a feedback system for assessing the proficiency of maintenance personnel. Under the Instructional System Development (ISD) concept, the training community is vitally interested in feedback from the fleet with regard to the skills of school graduates, but the process is still under development. The program instituted by CNET in 1977 using questionnaires distributed to recent school graduates has not provided useful data. Various NPRDC research programs have addressed the need for a performance proficiency assessment system and a personnel readiness training program. Pilot performance measurement tests have been developed for selected ratings (e.g. sonar technicians). These tests have been used, for example, to relate job performance to ASVAB test scores. We have not been able to determine their exact status nor the Navy's future plans in this area. Even with a proficiency assessment feedback system in place, proper diagnosis of material problems still would require on-site surveys by such activities as ship assist teams.

CONCLUSION #9: The present feedback systems permit early identification and immediate correction of operator and combat team skill deficiencies. They also permit identification of material problems possibly (but not necessarily) caused by personnel or training inadequacies. However, there is no feedback system to identify specific skill deficiencies of shipboard maintenance personnel. Diagnosis and correction of maintenance personnel or training inadequacies is a lengthy process, requiring on-site surveys by experts, and is limited by available funds to equipments in serious trouble Navy-wide which are under DART management. An expansion of this program would reduce the delays in diagnosing and identifying training deficiencies which are causing excessive equipment downtime. Alternatively, a proficiency assessment feedback system is required to identify maintenance skill deficiencies.

TRAINING REQUIREMENTS

Most changes in the formal training plan (i.e. identification of the training courses required for each billet) for the DD-963 were minor, except for the numbers to be trained. Changes included some migration of courses from formal schools to FLETRACEN. One major change was the introduction of the new gas turbine rating in 1978. Our study schedule did not permit a detailed review of course curricula, their changes over the intervening years, and the reasons for, and effects of, these changes.

Like the other Services, the Navy has experienced significant changes in the training environment over the last decade. The type of accessions has changed, with the proportion having civilian-acquired skills smaller than in the past. In the mid-seventies, the length of entry-level training was reduced (especially in "A" schools) with the introduction of the ISD concept. Implementation of ISD is still evolving, resource constraints limit the detail of the front-end analysis required, and the Navy has no good system for assessing graduates' skill deficiencies and changing training curricula.

More importantly, for the few sample equipments aboard the DD-963 which we analyzed, there were obvious problems due to the lack of devices for hands-on training. Many of the courses were "paper courses" until very recently, and some still are. This point will be addressed in the next section.

CONCLUSION #10: The training needed to attain skill proficiency is limited by resource constraints. For some technical maintenance skills, no hands-on training has been available in formal schools. As in the other Services, there has been a shift to increasing reliance on OJT, but the OJT provided on board is dependent upon the availability of skilled supervisors with the appropriate NECs.

TRAINING EQUIPMENT FUNDING

Our review of training for a few selected equipments aboard the DD-963 indicates that the acquisition program had great difficulty in obtaining funding for needed training devices. Many of the courses involved, however,

were not unique to the DD-963. For example, we have described how the lack of maintenance trainers for the AN/SPS-40B radar and Mk86 GFCS contributed to excessive downtime of these systems. The lack of a needed training device for NEC 1516 (SPS-40B operator/maintenance) was identified in 1973; it was installed in 1980. There was one maintenance trainer Navy-wide for NEC 1125 (Mk86 Mod 3 technician), but it was down most of the time. Additional trainers were planned for fiscal 1977 installation, but funding was deferred; maintenance trainers are now scheduled for installation in fiscal 1982.

Another example is the ASROC Weapon Handling System (NEC 0891). The necessary training equipment was installed late (1976) and was down 50 percent of the time. Design modifications (launcher simulator) were developed and installed in fiscal 1978. The Waste Heat Boiler course still has no training equipment. Funding was requested for fiscal 1980 installation at FLETRACEN San Diego, but not approved by OPNAV. Notably, all of these equipments are on the troubled equipment list. While we do not have evidence (with exception of AN/SPS-40 B and Mk86 GFCS) that availability problems were caused by poorly trained technicians, the lack of hands-on training would seem to be a contributing factor.

A story by itself is the lack of a device for system-level training of the propulsion technicians (NEC 4111, 4112 and 4115, all unique to DD-963), as documented in Chapter 2.

CONCLUSION #11: There were significant problems with the authorization of technical training equipment requirements, and delays in the funding, development and installation of training equipment. For some of the combat systems examined, these delays contributed to poor operational availability. Installation of needed training equipments will not be completed until after fiscal 1982, some seven years after commissioning of the lead ship, two years after commissioning of the final ship of the class.

RECOMMENDATIONS

The preceding conclusions have focused on problems with the Navy's management of manpower, personnel, and training for new ship acquisitions. Many changes have taken place since the period covered by this case study, and improvements have been made. Many of the problems identified may be attributed to the peculiarities of a TPP program, but some shortcomings are not peculiar to the DD-963 acquisition program. Consequently, we recommend that the ASD(MRA&L) use his influence and review authority to prompt the Navy to:

RECOMMENDATION #1: Improve the ship manpower validation process by requiring at-sea manning evaluation of the total ship within one year after commissioning of the lead ship of a class. Manning requirements directly associated with the ship's missions should be validated by the Navy's independent testing agent, OPTEVFOR. Validation of support manning requirements (facility maintenance, administration/support) may continue to be done by NAVMMAC, but existing procedures should be improved.

RECOMMENDATION #2: Strengthen the process by which training inadequacies are identified and fed back to the cognizant training and training support agents. Provide the funding and billets necessary to expand the use of assist teams as the primary vehicle for this feedback system.

RECOMMENDATION #3: Place more emphasis during the acquisition process on the identification, development, procurement, and installation of training equipment, to ensure that needed training equipment will be in place when Navy training courses for new or existing equipments installed aboard the ship are phased in.

RECOMMENDATION #4: Improve the process for estimating mature manning requirements for new ships by including error or growth margins for workload estimates in preliminary ship manning documents (PSMD), and by assessing the adequacy of final estimates (SMD) through a scenario-driven, dynamic simulation model.

APPENDIX A

CHANGES IN TRAINING REQUIREMENTS FOR SELECTED SYSTEMS

Changes in training requirements were analyzed by comparing the courses required for selected billets as detailed in the September 1974 and April 1979 Crew Scheduling and Phasing Plans (CSPP). CSPPs are published as separate annexes to NTPs. Whereas an NTP is system- and course-oriented, a CSPP is hull- and billet-oriented. It specifies the training required for each billet on a given hull (or group of hulls if manpower requirements are identical).

The billets selected for this analysis are those responsible for operating or maintaining the following equipments: the Antisubmarine Rocket (ASROC) Weapons Handling System (AWHS), the Mk 86 Gunfire Control System (GFCS), the AN/SPS-40B Radar Set, the LM 2500 gas turbine propulsion system, and the NATO SEA SPARROW. Additionally, the tentative new NEC requirements proposed in the May 1975 NTP are compared to those adopted as of 1980.

ASROC WEAPON HANDLING SYSTEM

The AWHS is part of the ship's antisubmarine warfare (ASW) fire control and AWHS subsystem. It operates in conjunction with the underwater fire control system (UFCS), sonar, torpedo tubes, and ASW aircraft to provide accurate placement of ASW weapons. The Mk 116 Mod 0 UFCS utilizes data from the AN/SQS-53 sonar to compute fire orders from the Mk 52 torpedo tubes, Mk 112 Mod 5 ASROC launcher, and ASW aircraft.

The AWHS is maintained by Ordnance Technicians (GMT-0891) at the ship (organizational) level. Among the required skills are preventive and corrective maintenance, including troubleshooting, fault isolation and diagnosis, repair, adjustment, alignment, calibration, and testing of equipment. Intermediate-level maintenance technicians assist the ship's force

with conventional intermediate support for electrical and hydraulic components. Civilian personnel at Navy shipyards provide depot-level maintenance (overhauls and major alterations).

Shipboard maintenance and operations are performed by the same personnel. Therefore, training has been combined into one course: AWHs Operation and Maintenance. Table A-1 summarizes the training requirements identified in the September 1974 and April 1979 CSPPs.

Changes in the training requirements are largely a result of increased manpower requirements. This accounts for the increase in the prerequisite course for NEC 0891 (ASROC Launching Group Mk 16 Maintenceman), Orientation and Indoctrination, Combat Team Training Afloat, and Operations/ Weapons Integration (which replaced Weapons Control Integration). Other changes resulted from the deletion of four courses from the training pipeline: Advanced Shipboard Firefighting, Introduction to NBC Defense/DC Procedures, AWHs Operation and Maintenance, and Nuclear Weapons Training of ASROC Handling Teams.

The requirement for AWHs Operation and Maintenance was deleted because this training was incorporated into the prerequisite training for NEC 0891 (course A-121-0010) which originally was just for the ASROC launcher. The other courses are still required but not considered enroute training requirements. Therefore, they are not scheduled in advance. Individuals assigned to a ship are scheduled for these FLTRACEN courses by the ship at its convenience.

AN/SPS-40B SURVEILLANCE RADAR SET

The AN/SPS-40B Radar Set is a long-range, two-dimensional air surveillance radar set installed aboard DD-963 class ships. The ET-1516 Radar Technicians are responsible for organizational maintenance of the AN/SPS-40B

TABLE A-1. TRAINING FOR ENLISTED PERSONNEL - AWHs

COURSE	BILLET DESCRIPTION									
	GMT1 (0891)		GMT2 (0891)		GMT3 (0891)		GMTSN (0891)		Total	
	Sep. 74	Apr. 79	Sep. 74	Apr. 79	Sep. 74	Apr. 79	Sep. 74	Apr. 79	Sep. 74	Apr. 79
Prerequisite Course for NEC 0891 and A-121-0010	1	1	1	1	2	3		1	4	8
AMIS Operation and Maintenance PMS 389-4022 (4.0 weeks)	1		1		2				3	0
Nuclear Weapons Training for ASROC Handling Supervisors K-000-9018 (1.0 week)	1	1							1	1
Nuclear Weapons Training for ASROC for ASROC Handling Teams K-000-9012 (1.0 week)	1		1		2				4	0
Nuclear Safety and Weapons Admin. Training Course for Cruiser/Destroyer Force K-000-9032 (1.0 week)	1	1							1	1
Orientation and Indoctrination PMS 389-4001 (1.0 week)	1	1	1	3	2	3		1	4	8
Weapons Control Integration PMS 389-4003 (1.0 week)	1		1						2	0
Combat Team Training Afloat PMS 389-4039 (1.0 week)	1	1	1	3					2	4
Advanced Shipboard Firefighting K 780-2017/1 780-4102 (1.0 week)	1		1		2				4	0
Introduction to NBC Defense/DL Procedures K700-PC011/1 780-4062 (1.0 week)	1		1		2				4	0
Command and Decision Team Training Ashore PMS 398-4037 (2.0 weeks)			1						1	0
Operations/Weapons Integration PMS 389-5003/1 250-0313 (1.0 week)		1		3					0	4

radar. Table A-2 lists the training requirements for these billets as listed in the September 1974 and April 1979 CSPPs.

The major changes here resulted from the deletion of the requirement for Damage Control, Video Mixer, and Advanced Shipboard Firefighting courses in the April 1979 CSPP. The Video Mixer course was included in the "C" school curriculum. The other courses are no longer enroute training and hence not scheduled in advance.

Mk 86 GFCS

The Mk 86 GFCS is used to direct and fire the 5"/54-caliber guns against surface, air, and shore targets. The system consists of a digital computer, operator consoles and both radar and optical sensors.

Table A-3 lists the training requirements for Mk 86 GFCS technicians (FTG 1125) listed in the September 1974 and April 1979 CSPPs.

The comparison shows no change in Orientation, Combat Team Training Afloat, and Data Processing/Software Utilization courses. Changes in course title (which had little affect on the training pipeline) resulted from the substitutions of Operations/Weapons Integration for Weapons Control Integration and three separate Mk 86 courses for AAW Subteam Training. The former substitution resulted from the merging of two courses, Operations Control Integration and Weapons Control Integration, into one course, Operations/Weapons Integration. Length of training was not affected. The latter substitution occurred with Navy takeover of instruction from the contractor and increased the length of training by one week.

Uncompensated changes consist of the deletion of introduction to NBC Defense/DC Procedures and Advanced Shipboard Firefighting. As stated earlier, the courses are no longer enroute training and hence scheduled by the ship at its convenience.

TABLE A-2. TRAINING REQUIREMENTS FOR ENLISTED PERSONNEL - AN/SPS-40B SURVEILLANCE RADAR

COURSE	BILLET DESCRIPTION							
	ETR1 (1516)		ETR2 (1516)		ETR3 (1516)		Total	
	Sep. 74	Apr. 79	Sep. 74	Apr. 79	Sep. 74	Apr. 79	Sep. 74	Apr. 79
Prerequisite Course for NEC 1516 A-104-1024/1033	1	1		1	1		2	2
Damage Control (PQS-2) K-7802004/ J-780-4032 (1.0 week)	1				1		2	0
Soon-to-Exist Package Course Blank Video Mixer A-102-0094 Revised (unknown)					1		1	0
Operation/Weapon Integration J-250-0313 (1.0 week)		1					0	1
Miniature Component Repair C-000-3182 (2.0 weeks)	1	1					1	1
Microminiature Component Repair C-000-3187 (2.0 weeks)	1	1					1	1
Orientation and Indoctrination PMS 389-4002 (1.0 week)	1	1		1	1		2	2
Advanced Shipboard Firefighting K-780-2017/J-780-4102 (1.0 week)	1				1		2	0

TABLE A-3. TRAINING REQUIREMENTS FOR ENLISTED PERSONNEL - Mk 86 GFCS

COURSE	BILLET DESCRIPTION									
	FTCC (1125)		FTG1 (1125)		FTG2 (1125)		FTG3 (1125)		Total	
	Sep. 74	Apr. 79	Sep. 74	Apr. 79	Sep. 74	Apr. 79	Sep. 74	Apr. 79	Sep. 74	Apr. 79
Prerequisite Course for NEC 1125	1	1	1	1	1	1	1	2	4	4
Weapons Control Integration PMS 389-4003 (1.0 week)	1	1	1	1	1	1	1	1	4	0
Command and Decision Team Training Ashore PMS 389-4037 (2.0 weeks)	1	1	1	1	1	1	1	1	3	1
Integration to NBC Defense/DC Procedures K-700-PC01/J-780-4062 (1.0 week)	1	1	1	1	1	1	1	1	4	0
Administration and Operation of Shipboard 3-M System K-000-2003/J-500-0252 (1.0/0.8 week)	1	1	1	1	1	1	1	1	2	0
NTDS Tracker/Supervisor J-221-3532/K-221-0039 (3.0 weeks)	1	1	1	1	1	1	1	1	1	0
Data Processing/Software Utilization PMS 389-4008 (5.0 weeks)	1	1	1	1	1	1	1	1	1	1
Orientation and Indoctrination PMS 389-4001 (1.0 week)	1	1	1	1	1	1	1	2	4	4
Advanced Shipboard Firefighting K/730-2017/T-780-4102 (1.0 week)	1	1	1	1	1	1	1	1	4	0
Combat Team Training Afloat PMS 389-4039 (1.0 week)	1	1	1	1	1	1	1	2	4	4
AAM Subteam Training PMS 389-4045 (1.0 week)	1	1	1	1	1	1	1	1	3	0
Operational Weapons Integration PMS 389-5003/J-250-0113 (1.0 week)	1	1	1	1	1	1	1	2	0	4
Prerequisite Course of NEC 9535	1	1	1	1	1	1	1	1	0	1
GLCS, Mk 86 Orientation J-02E-0114 (1.0 week)	1	1	1	1	1	1	1	2	0	3
GFCS, Mk 86 Operator J-113-0115 (1.0 week)	1	1	1	1	1	1	1	2	0	1
GFCS, Mk 86 Naval Gunfire Support Support Basics G-20-6405 (1.0 week)	1	1	1	1	1	1	1	2	0	3

UNIQUE TRAINING PIPELINES

The DD-963 class has only eight unique training pipelines (NEC). Requirements for NECs for the ET and DS ratings were recommended in the 1975 NTP. The GS rating did not exist at the time of the 1975 NTP. However, the NTP recommended one new NEC for a gas turbine automated propulsion control system operator and one new NEC for a gas turbine automated propulsion control system maintenance technician. The source ratings for these new NECs were identified as engineman (EN) and interior communications (IC) electrician, respectively. The gas turbine rating (GS) was approved by the Rating Review Board in January 1978 and resulted in a change of the training concept for the DD-963 propulsion system operators and maintainers.

The EN-4398 pipeline is basically the same as the pipeline for the EN-4294 (Refrigeration and Air Conditioning Mechanic) listed in the July 1974 CSPP. The difference is that non-NEC-awarding courses listed in the 1974 CSPP were grouped together to form a new NEC requirement. To obtain the 4398 NEC, enlisted personnel must have NEC 4291 (Centrifugal Air Conditioning Mechanic) plus several additional courses (vibrational analyses, waste heat boiler, hydraulic systems components, sewage treatment and distilling plant). To obtain NEC 4291, personnel must have the 4294 NEC plus the course in Centrifugal Air Conditioning Plants. Thus, an EN-4398 is an EN-4294 with additional courses, most of which were listed in the 1974 CSPP.

The EM-4626 receives instruction in the operation and maintenance of the degaussing system, basic circuit concepts for gas turbine controls, and maintenance of the 60/400 Hz power converters. This instruction was included for EM-43XX (a proposed new NEC for a gas turbine automated propulsion control system operator) personnel in the 1974 CSPP.

PROPULSION SYSTEM

Table A-4 lists the courses taken by the operators and maintainers of the propulsion system. Training requirements for the different rates and NECs have been summarized under the appropriate ratings. The 1974 CSPP stated a requirement for EMs, ICs and ENs. The 1979 CSPP, reflecting the decision in early 1978 to create a GS rating, specifies GSEs and GSMs for propulsion system operation and maintenance. (Training pipelines for GS personnel were first promulgated in July 1978 following the Marine Gas Turbine NTPC, held in May and June 1978). Requirements for NECs are not listed explicitly. However, the courses required for the various NECs are included in the courses listed so that Table A-4 reflects NEC prerequisite courses as well as subsequent training.

There are four major reasons for the changes in these training requirements. The first involves the transfer of responsibility for certain pieces of equipment originally assigned to personnel responsible for the propulsion system. The second is the introduction of the new GS rating. The third is additional manpower requirements, and the fourth is the decision not to schedule certain TYCOM training requirements in the CSPP as mentioned earlier.

- (1) Equipment Responsibility Transfers. The creation of the DD-963 unique training pipeline EM-4626 relieved propulsion system personnel of responsibility for the 60/400 Hz converters and the degaussing system. Hence, the 1979 CSPP has no training requirements for these equipments for GS personnel. Similarly, the creation of the GS ratings relieved IC personnel of propulsion system maintenance. This caused the deletion of courses in miniature and micro-miniature component repair, dead reckoning analyzer indicator, dial telephone equipment maintenance, and gyrocompass differences maintenance. Gyrocompass and telephone maintenance is now provided by ICs without collateral propulsion system responsibility. Miniature and microminiature component repair courses are given only to ET personnel in the 1979 CSPP. (They were given to IC and ET personnel in the earlier CSPP).

An equipment responsibility transfer was also responsible for adding a course in the 1979 CSPP. Waste heat boiler maintenance was the responsibility of EN personnel without collateral propulsion system

TABLE A-4. PROPULSION SYSTEM TRAINING REQUIREMENTS
FOR ENLISTED PERSONNEL

COURSE	1974 CSPP Ratings			1979 CSPP Ratings		TOTAL	
	EM	IC	EN	GSM	GSE	Sept 74 CSPP	April 79 CSPP
Orientation and Indoctrination PMS 389-4001, J-010-0021 (1.0 week)	7	4	11	20	7	22	27
Propulsion System Integration PMS 389-4004, J-651-0461 (1.0 week)			2	20	7	2	27
Auxiliary Systems Integration PMS 389-4005, J-652-0462 (1.0 week)	5		3	3		8	3
LM-2500 Propulsion Turbine Maintenance PMS 389-4023, A-652-0072 (5.0 weeks)			9	14		9	14
Engineering Control and Surveillance System Operation PMS 389-4024, A-652-0074 (3.0 weeks)	7		8	14	7 (4 weeks)	15	21 (4 weeks)
Engineering Control and Surveillance System Maintenance PMS 389-4025 (8.0 weeks)		3				3	0
Power Train Maintenance PMS 389-4026, A-652-0078 (1.0 week)			6	1		6	1
Hot Plant Familiarization PMS 389-4027 (1.0 week)		1	5			6	0
60/400 Hz Power Converter Maintenance PMS 389-4028, A-652-0077 (2.0 weeks)	2					2	0
Dial Telephone Equipment Maintenance PMS 389-4031 (4.0 weeks)		1				1	0
Gas Turbine Ship Service Generator Operation and Maintenance PMS 389-4032, A-652-0076 (5.0 weeks)			10	14		10	14
Waste Heat Boiler Maintenance PMS 389-4033, A-652-0073 (1.0 week)				4		0	4
Damage Control/Fuel Control Console Operation PMS 389-4034, A-652-0079 (2.0 weeks)				3		0	3
Damage Control/Fuel Control Console Maintenance PMS 389-4035, A-652-0081 (3.0 weeks)		3			2	3	2
MK-19 Mod 3E Gyrocompass Differences Maintenance PMS 389-4047 (1.0 week)		1				1	0
Degaussing System Operation and Maintenance PMS 389-4048 (2.0 weeks)	3					3	0
DD-963 Vibration Analysis Equipment Operation PMS 389-5001, A-652-0084 (1.0 week)	2		2	3	2	4	5

**TABLE A-4. PROPULSION SYSTEM TRAINING REQUIREMENTS
FOR ENLISTED PERSONNEL
(Continued)**

COURSE	1974 CSPP Ratings			1979 CSPP Ratings		TOTAL	
	EM	IC	EN	GSM	GSE	Sept 74 CSPP	April 79 CSPP
Marine Gas Turbine Basics A-652-0027 (4.0 weeks)			10	1 (6 weeks)		10	1 (6 weeks)
Basic CRP Propeller A-652-0028 (3.0 weeks)			6			6	0
Propulsion System Indoctrination A-652-0133 (2.0 weeks)				14	7	0	21
Auxiliary Boiler Feedwater A-651-0054 (0.5 week)				3		0	3
Engineering Fueling Systems JP-5 Shipboard K-621-2039 (0.6 weeks)			1	1		1	1
Basic Electricity and Electronics A-100-0011 (3.0 weeks)				1		0	1
Miniature Component Repair C-000-3182 (2.0 weeks)		2				2	0
Microminiature Component Repair C-000-2139 (2.0 weeks)		2				2	0
Dead Reasoning Analyzer Indicator A-623-0028 29 (3.0 weeks)		2				2	0
3-M System for Documentors K-000-1011/ J-7E-0232 (2.0 weeks)	6	1	2			9	0
Administration and Operation of the Ship- board 3-M System K-000-1003/J-500-0252 (1.0 week)	1		1			2	0
Division Damage Control Petty Officer K-780-2006 (1.0 week)	1		1			2	0
Damage Control (PQS-2) K-780-2004/ J-780-4032 (1.0 week)	7	4	11			22	0
Advanced Shipboard Firefighting K-780-1017/J-780-4102 (1.0 week)	7	4	11			22	0
Basic Circuit Concepts for Gas Turbine Controls A-652-0134 (2.0 weeks)					7	0	7
Electrical Plan Control System A-652-0179 (0.5 weeks)					5	0	5
Propulsion System Controls Maintenance A-652-0075 (10 weeks)					2	0	2

NOTE: One GSM is listed as GSM in this table.

responsibility in the 1974 CSPP. However, it was the responsibility of GS personnel in the 1979 CSPP.

- (2) Manpower Changes. Certain increases in the number of personnel taking courses are due to the increased manpower reflected in the 1979 CSPP. These courses include orientation and indoctrination, propulsion turbine maintenance, ECSS operation, and gas turbine ship service generator operation and maintenance.
- (3) Courses Eliminated from the CSPP. Courses which are no longer scheduled in the CSPP include 3-M system operation, administration and documentation, as well as the previously mentioned courses in damage control and firefighting.
- (4) New Ratings. Major increases and decreases in the number of personnel taking specific courses are the result of the introduction of the gas turbine rating and NECs. The course in CRP propeller was deleted when the topic was incorporated into GS "A" school training. The requirements for power train maintenance and marine gas turbine maintenance dropped significantly because those topics are now taught in GS "A" school. The requirement for hot plant familiarization was dropped when the plant used for training was placed aboard a ship. (This did not remove the requirement for system-level training, but in the absence of a hot plant or simulator at the schools, this training must be done as part of OJT aboard ship.)

The new ratings also generated additional courses. These include basic circuit concepts for gas turbine controls, electric plant control system operation, propulsion system controls maintenance, propulsion system indoctrination, and basic electricity and electronics. The propulsion system controls maintenance course is not entirely new but actually a stretched version of the earlier ECSS maintenance course which is now eliminated. The basic electricity and electronics requirement is actually a prerequisite to GS "A" school. However, until the training pipeline matures, it is listed for one senior petty officer (GSCM). The course in basic circuit concepts is part of the pipeline for NECs 4112 and 4115. Electric plant controls is part of the pipeline for NEC 4112. The propulsion system indoctrination course is part of the pipeline for NECs 4111, 4112, and 4115. All three NECs are unique to the DD-963 class.

NATO SEA SPARROW

The NATO Sea Sparrow Surface Missile System has been selected by the Navy for testing a new training concept, the Enlisted Personnel Individualized Career System (EPICS). This is a research and development program conducted by the Navy Personnel Research and Development Center (NPRDC). The objective of this program is to reduce manpower, personnel, and training costs without reducing readiness through a new approach to training, both entry-level and

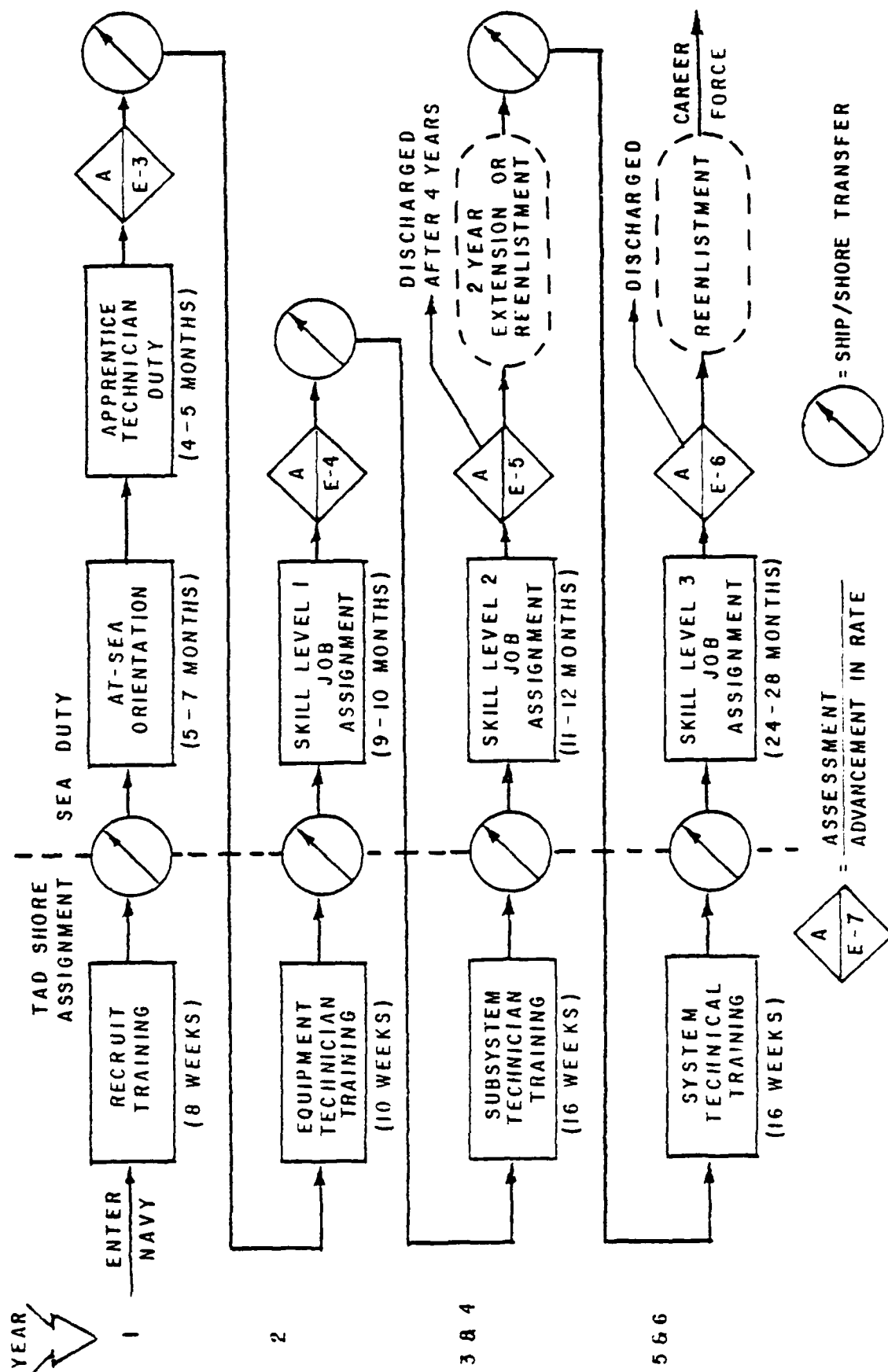
career progression. There are four major characteristics of the EPICS program. The first is early job performance. Personnel are placed aboard ship after completion of recruit training; they receive four months of ship orientation followed by hands-on technical training. The use of job performance aids is key to allowing minimally trained personnel to perform useful tasks. The second concept is distributed training. Front-end technical training is deferred while personnel alternate between phases of shore-based and shipboard training. The third concept is individualized training. Building blocks of experience and training lead to vertical and horizontal career moves to match each individual's abilities. The fourth concept is improved personnel utilization. The opportunity for a technical career is open to everyone and the fleets receive "ship-wise" technicians.

Figure A-1 illustrates the career progression of personnel participating in the EPICS program. Alternating phases of sea duty and shore-based training are distributed over six years. The front-end emphasis is on ship experience rather than formal training.

The pilot program will place 189 EPICS technicians aboard 45 different ships (120 technicians aboard 30 DD-963 class ships) to operate and maintain the NATO SEA SPARROW (FTM and GMM ratings). An evaluation will be made over a four-year period beginning in 1980. The program will be analyzed to determine its impact on personnel performance, retention, and morale.

This training technology demonstration program may show that EPICS provides a feasible and cost-effective approach to solving the personnel/training problems faced by the Navy today: increasing complexity of equipment; decreasing quality of accessions (civilian education, acquired skills and aptitudes); budgetary limitations on school training; and poor retention,

FIGURE A-1. TYPICAL PHASES OF EPICS CAREER



SOURCE: PERFORMANCE MEASUREMENT AND ENHANCEMENT PROGRAM - CODE 309, NPRDC

especially in the technical skill- causing a shortage of supervisory personnel. Availability of the latter, possessing both technical competence and teaching skills, is, of course, instrumental to a successful implementation of EPICS.

APPENDIX B

THE DEVELOPMENT OF A SHIP MANNING DOCUMENT

A ship manning document (SMD) describes the organizational manning requirements of a ship. It identifies the manning need for operation, maintenance, and on-board support of the ship under stated conditions of readiness (Table B-1) and shows the assignment of personnel to specific stations and tasks. The key assumptions under which an SMD is developed are stated explicitly as a ROC, a POE and an operating profile.

TABLE B-1. SHIP READINESS CONDITIONS

Condition I: Battle Readiness.* All stations manned. No sleep. Urgent repairs only. Maximum 24 hours.

Condition II: Battle Readiness - Limited Action. Most stations manned. Six hours sleep. Urgent preventive and corrective maintenance only. Maximum ten days.

Condition III: Wartime Cruising Readiness. Specified stations manned. Eight hours sleep. Normal maintenance. Maximum 60 days.

Condition IV: Peacetime Cruising Readiness. Systems manned only for ship control, propulsion and security. Normal maintenance. Endurance not manpower constrained.

Condition V: In-Port Readiness. Manning based on situation and security needs. Normal maintenance. Maximum opportunity for training, rest, leave and liberty.

* Special conditions 1A and 1M apply to amphibious operations and mine counter measures, respectively.

The ROC is a formal description of the specific functions which must be performed by the ship in accomplishing each of its assigned missions. It breaks down each mission into its functional elements and identifies the degree of capability to be achieved under each readiness condition. An extract of a typical ROC is shown in Table B-2. A matrix display may be used

to show how the manning of each station contributes to the accomplishment of each capability during each readiness condition. In Table B-3, for example, station A1 contributes during Condition I to the accomplishment of anti-air warfare (AAW) capabilities 1.2, 3.1 and 4.1.

TABLE B-2. REQUIRED OPERATIONAL CAPABILITY (EXTRACT)

		Readiness Condition			
		I	III	V	OFF W
ANTI-AIR WARFARE (AAW)					
AAW-8 Detect, Identify, and Track Air Targets.					
AAW-8.2	Recognize by sight friendly and enemy aircraft which may be encountered in expected operating areas.	F	F		
AAW-8.6	Acquire and track air targets with GFCS/FMFCs. III (P) - Assumes shift to Condition I when attack probable or upon reaching raid saturation.	F	P		
AAW-9 Control Combat Air Patrol					
AAW-9.1	Conduct CAP and air intercept control against aircraft attack/ECM. III (P) - AIC watch not continuous requirement. Augment by off-watch personnel as required.	F	P		A

OFF W: Accomplished as required by off-watch personnel
 F: Capability is to be fully achieved
 P: Capability is to be partially achieved
 A: Assistance of off-watch personnel is required

TABLE B-3. WATCH STATION/ROC RELATIONSHIP MATRIX

ROC		AAW 1.2	AAW 1.4	AAW 3.1	AAW 3.2	AAW 4.1
Station Number	Cond.					
A1	I	X		X		X
	III	X		X		
A2	I		X			
	III		X			
A3	I		X			
	III		X			
A4	I	X				X
	III	X			X	

The projected operating environment describes broadly the most demanding condition of operation for which the ship must be manned. An example of a POE for a typical destroyer is displayed in Table B-4. A POE is not normally written during ship design or construction because more detailed descriptions of the ship's operational environment are available (e.g., the NDCP).

TABLE B-4. POE FOR DDX CLASS SHIPS

1. At sea in wartime.
2. Capable of performing all offensive and defensive functions simultaneously while in Readiness Condition I.
3. Capable of performing other functions which are not required to be accomplished simultaneously.
4. Continuous Readiness Condition III at sea.
5. Capable of performing all maintenance for which ship's company is assigned responsibility.

The planned pattern of operation of the ship is described by an operating profile. It specifies the overhaul cycle, projected availabilities, upkeep periods, deployment durations, and minimum readiness to get underway. Whereas the ROC describes the reasons for having the ship, an operating profile such as that shown in Table B-5 describes how the ship will be used and, to a limited extent, how it will be supported. The two together, plus knowledge of the ship configuration, form the basis of manning requirements.

Ship manning is derived from analysis of five categories of workload: (1) operational, (2) maintenance, (3) administrative and support, (4) utility tasks and evolutions, and (5) customer support. Operational workload is associated with the manning of operating stations during each of the conditions of readiness. Watches are manned continuously during the condition; other stations are manned only during the performance of specific functions.

TABLE B-5. OPERATING PROFILE FOR DDX CLASS SHIPS

1. Overhaul Cycle
 - a. Regular overhaul cycle is 36 months.
 - b. Planned overhaul duration is 3 months.
 - c. One interim availability of 3 weeks duration will normally be scheduled near the mid-point of each overhaul cycle.
2. Routine Employment
 - a. Non-deployed (CONUS-based operations).
 - (1) Excluding regular overhauls, the DDX shall be available for operation a minimum of 60% of the time. Upkeep periods including tender, restricted and interim availabilities shall comprise the remaining 40%.
 - (2) Planned underway days shall approximate 50% of available days (non-continuously) including refresher training.
 - b. Deployed (extended operations in a distant area).
 - (1) Scheduled deployment duration of 6 months.
 - (2) Ships rotate on a one-in-three basis. Relief is on station.
 - (3) One month is planned for transit to and from the area of deployment in each deployment cycle.
 - (4) The DDX shall be available for operation 77.5% of days deployed. Upkeep periods including tender and restricted availabilities shall comprise the remaining 22.5%.
 - (5) Planned underway days shall approximate 90% of available days (non-continuously).
3. Emergency Employment
 - a. The DDX shall be available for operation 75% of the time excluding overhaul.
 - b. Planned underway days may equal 100% of available days in continuous periods of up to 60 days.
4. Readiness to Get Underway
 - a. In-port: ready
 - (1) Routine: 24 hours
 - (2) Emergency: 2 hours (ship alerted)
 - b. Scheduled upkeep (including tender and technical availabilities).
 - (1) Routine: 4 days CONUS/48 hours deployed.
 - (2) Emergency: 4 hours (ship alerted)

During ship design, much attention is devoted to minimizing the number of Condition III watches because each requires the assignment of three people, one to each eight hour shift. Condition I watches, though more numerous than those of Condition III, must be manned for only 24 hours, therefore requiring the assignment of only one man per station. Usually, if Condition III requirements can be met, there will be sufficient personnel to satisfy also the Condition I requirements. Because watches and other operating stations are concerned directly with the operation of the ship and its weapon systems, operational manning requirements are strongly influenced by traditional Navy practices for operating and manning ships.

Maintenance workload is comprised of preventive maintenance (PM), corrective maintenance (CM) and facility maintenance (FM). A ship's manning is organized into departments and, within department, into divisions. Maintenance workload, measured in man-hours, is calculated by category for each division on an average weekly basis. PM requirements for most ship equipments have been established through the Navy Material Maintenance Management (3M) System and are documented on maintenance index pages (MIP). A MIP identifies for a piece of equipment, each scheduled maintenance action, the frequency of performance, the time each task takes, and the skills required. For equipments not documented by a MIP, PM requirements must be estimated by analogy to similar, documented equipments or by engineering analysis. The estimated PM workload for all equipments within the responsibility of a division are aggregated by skill and inflated by 30% to account for make ready, put away and data recording time.

Several methods can be used to estimate CM. The usual is to ratio CM to PM; 1:1 for electronics and fire control systems and 1:2 for all other equipments. Although CM data can be obtained from the 3M system, it is not considered

reliable and is seldom used. When CM is estimated from 3M data, a factor of .25 manhours per maintenance action for data recording (prorated among billets assigned CM within a work center) is applied in lieu of the factor for make ready and put away time. For new equipments, CM can be estimated from engineering analyses if the failure rates and repair times are realistic and allowances are made for make ready, put away and data recording.

FM is the routine housekeeping, done mostly by non-rated personnel (pay grades E-3 and below), to maintain cleanliness and preserve the ship against corrosion and deterioration. There is no standard methodology for estimating FM workload. NAVSEC has a set of standards, such as those shown in Table B-6, that it uses for estimates of FM. PATAO has developed a FM model, but the model has not yet been validated and is not in general use. For existing ships, FM workload is estimated from data collected during on-board surveys. Regression analysis of that data also is sometimes used to estimate FM workload on a new ship.

Administrative and support workload includes a variety of tasks: preparation of correspondence, record keeping, publishing directives and plans, shipboard storekeeping, food preparation and service, disbursing and financial management, medical support, etc. Because of the diversity of services included in the administrative and support workload, there is no prescribed methodology for determining manning requirements. The workloads in some functional areas are estimated from data reflecting experience on existing ships. For some functions, such as food service, the manning for the function is a standard fraction of total ship complement (e.g., one mess man per 20 crew members). For other services, such as medical support, the manning is determined by Navy policy and the nature of shipboard facilities.

TABLE B-6. SAMPLE FACILITY MAINTENANCE STANDARDS

<u>Cleaning of Bulkhead Surfaces</u>			
All standards expressed in allowed minutes per square foot of surface			
Description of Task	Equipment to be Used	Remarks	Standard Minutes
Wipe	Damp rag	Going over for scuffs and finger marks	.050
Scrub	Rag and sandsoap Rinse wipe	Thorough cleaning	.163
The above standards are for relatively clear and open bulkheads with few protrusions. For bulkheads which are cluttered and congested use:			
Dust	Foxtail	Same as above	.005
Wipe	Damp rag		.074
Scrub	Rag and sandsoap		.300
<u>Cleaning of Deck Surface</u>			
Sweep	Pushbroom		.019
Damp mop	Swab and bucket		.026
Scrub	Long handle brush and swab		.061
Scrub	Electric scrubber	Incl. mopping	.051
Apply wax	Swab or applicator		.023
Buff	Electric buffer	Use double time if both brush and pad polishing desired	.032

Utility tasks and evolutions are miscellaneous work and tasks not otherwise included in workload computations. Utility tasks include line handling, boat operations, cargo handling, fire watches, and similar miscellaneous chores. Evolutions are tasks required to provide a specific functional capability such as piloting, anchoring, mooring, replenishment at sea, towing and helicopter operations.

Customer support workload applies only to tenders and repair ships. The workload includes intermediate maintenance and other support services provided by those ships. Customer support requirements are not well defined. Consequently there are not yet any SMD for tenders and repair ships.

Workload calculations are completed by adding allowances for productivity, service diversions and training. The productive allowance of 20% is added to all workloads except watchstanding, certain evolutions, and workloads for which the estimate already includes some productive allowance (e.g., those estimated by sampling). The productive allowance reflects the average, additional time required to do tasks because of fatigue, environment, personnel needs and unavoidable interruptions. The service diversions allowance accounts for the average time a man spends at such miscellaneous, non-productive activities as quarters, inspections, sick call, pay line, haircuts, etc. For new ships, standard factors, shown in Table B-7, are used to estimate service diversions. Similarly, standard factors are used to allow for time spent doing on-board training (see Table B-8). No allowance is made for proficiency training which is conducted while watchstanding or for off-ship training, which is conducted while in port. Nor is an allowance normally made for leave and liberty. It is usually assumed that the most demanding environment for a ship is combat at sea and that providing sufficient personnel for that environment will guarantee sufficient personnel for in-port activities, even

TABLE B-7. STANDARD SERVICE DIVERSION ALLOWANCES

(Hours Per Week)

Element	Condition III		Condition IV		Condition V	
	WS	NWS	WS	NWS	WS	NWS
Quarters	1.00	1.50	1.00	1.50	1.18	1.25
Inspections	--	--	.67	1.00	1.42	1.50
All Other	1.50	1.50	1.50	1.50	1.25	1.25
Total	2.50	3.00	3.17	4.00	3.85	4.00

WS: Watchstander

NWS: Non-Watchstander

TABLE B-8. ONBOARD TRAINING TIME FACTORS

(Hours Per Week)

Element	Condition III		Condition IV		Condition V	
	WS	NWS	WS	NWS	WS	NWS
Formal Training	.67	1.00	1.67	2.50	1.88	2.00
Drills & Practices	1.33	2.00	3.33	5.00	.47	.50
Total	2.00	3.00	5.00	7.50	2.35	2.50

WS: Watchstander

NWS: Non-Watchstander

though some personnel will be attending off-ship training or taking leave or liberty. The Navy is now realizing that the reduced availability of personnel while in port often precludes accomplishment of all workload. OPNAV 10P-23 prescribes a methodology to be used to determine if there are sufficient billets to provide each crew member with an average 20-days leave per year. Regardless of the result, however, Navy ships are manned for sea duty, not in-port workload.

Finally, an allowance of 1.5% is applied to compensate for ineffectiveness due to emergency leave and sick time. The workload added by this allowance is distributed only to paygrade E-3 positions.

Once workloads have been calculated, by skill within division, the workloads are translated to manning requirements according to the following procedures. (See Table B-9.) First, watchstanding requirements are identified and the associated watchstanding workload noted. Next, a portion of the CM workload is used to fill the slack time of the watchstanders. (The total time a watchstander has available for productive work is specified as a Navy standard workweek. See Table B-10.) The number of non-watchstanders is calculated by dividing the total remaining workload, in each skill and division, by the productive time available per man. Although the Navy standard workweek differentiates between scheduled and unscheduled work (presumably corresponding to PM and CM), no distinction is made in calculating manning requirements. To account for cross-utilization of personnel, thus reducing manning requirements, workload can be shifted up one grade or skill level to fill slack time. Directed manning for such positions as master-at-arms and 3M coordinator is added without regard to workload. A check is made to insure that sufficient personnel, with the needed skills, will be available to accomplish evolutions. Finally, the grade mix of the manning requirement is adjusted to insure adequate supervision and to achieve a suitable military command structure.

The end product of the SMD procedure is a voluminous document that describes, not only the manning requirements, but the rationale used to derive those requirements and the specific station and workload responsibilities assigned to each crew member during Conditions I, III and V and evolutions. Table B-11 shows the prescribed contents of an SMD.

TABLE B-9. SMD PROCEDURES

(OPNAV 10P-23)

- Identify watchstations and determine requirements for watchstanders
- Sum workloads by category, grade, and skill level
- Add allowances for productivity, service diversions and training
- Calculate non-watchstanding requirements (workload ÷ productive time available per man)
- Minimize manning by shifting workloads up one grade or skill to fill slack time
- Add directed manning (e.g., master-at-arms and 3M coordinator)
- Verify that enough personnel will be available to accomplish evolutions (underway replenishment)
- Adjust grade mix to insure adequate supervision and military command structure

TABLE B-11. PRESCRIBED SHIP MANNING DOCUMENT CONTENTS

SECTION/TITLE

1. Foreword
2. Definition of Terms
3. Navy Standard Workweek Afloat
4. Doctrinal Constraints
5. Summary of Organizational Manning Requirements
6. Officer Billet and Station Summary

APPENDICES

- A. Condition I, III and IV Watch Assignments
- B. Table of Evolution Details and Utility Tasks
- C. Table of Administrative and Support Tasks
- D. Table of Maintenance Manning Requirements
- E. Ship Manning Requirements Analysis Chart (Conditions I and III)
- F. Ship Manning Requirements Analysis Chart (Condition V)
- G. Summary of Battle Manning Requirements

TABLE B-10. NAVY STANDARD WORKWEEK

Workweek Component	Condition III		Condition IV		Condition V	
	Watchstander	Non-Watchstander	Watchstander	Non-Watchstander	Watchstander	Non-Watchstander
(1) Condition Watch	56.0	-	56.0	-	9.33	-
(2) Service Division & Training	4.5	6.0	8.17	11.5	6.20	6.5
(3) Scheduled Work*	13.5	40.5	Breakout Not Standardized in Cond. IV		28.67	31.0
(4) Unscheduled Work*	-	19.5			.80	3.5
(5) Total Productive Work (Sum of 3 and 4)	13.5	60.0	9.83	54.5	29.47	34.5
(6) Total Workweek	74.0	66.0	74.0	66.0	45.0	41.0
Comments	Six-day scheduled workweek plus Sunday watch. Three-section watch. Five-day scheduled workweek plus weekend watch. Six-section duty rotation: 1 day in 6 duty rotation and 1 in 5 watch rotation.					

* Scheduled work is defined as work planned during normal working hours. Unscheduled work is defined as work to be accomplished outside normal working hours, including CM, UT and cross-utilization in watchstanding: "To the maximum extent feasible, unscheduled work shall be assigned to non-watchstanders." OPNAV IOP-23 is somewhat ambiguous about the need to reflect this breakdown of productive time available in the PSMD computations. In any event, in the present case study this breakdown was not accommodated; the only constraint considered was the given total productive worktime available.

Note: Standard workweek applies only to the Readiness Conditions shown. Condition I (Battle Readiness) has maximum duration of 24 continuous hours, Condition II (Battle Readiness--Limited Action) has maximum expected endurance of ten continuous days. Condition III is limited to 60 continuous days while crew endurance in Condition IV & V is not manning constrained.

Source: OPNAV IOP-23.

The entire SMD process has been automated and incorporated in the Navy Manpower Requirements System (NMRS). The system is used for development of PSMDs as well as SMDs. Input to the system includes:

- preventive maintenance (PM) workload including rating, paygrade and NEC. This data is extracted from the Maintenance Data Bank (MDB) supporting the Navy Maintenance and Material Management (3M) system. Given a list of onboard equipment to be maintained, MDB provides the required workload data which following analyst verification or correction, is input into NMRS. (Analyst interface is required to reflect multiple installations of identical equipments and workload requirements for new equipments not yet included in MDB.) Following verification, the corrective maintenance (CM) workload is input based on given ratios of CM to PM.
- watchstation data including rating, paygrade and NEC. This data is extracted from the Watchstation Standards (WSS) module which is interfaced with NMRS via a random access file. WSS generates watchstation requirements based on the ship's mission, statements of ROC and POE. This data is also subject to analyst revision prior to entry into NMRS.
- facility maintenance (FM)/own unit support (OUS) workload. This data is maintained on the NMRS data base by class of ship.
- ship organization
- customer support workload if applicable (e.g., tender)

With all of the above available on the data base, processing is initiated through input specification of the following parameters:

- watch parameters, including:
 - the readiness conditions to be considered in developing the SMD

- the operational workload (man-hours/week) for each of the POE-driven watchstations: underway replenishment, vertical replenishment, flight quarters, and anti-submarine warfare flight quarters
- number of sections per watchstation for Condition III (wartime cruising), Condition IV (peacetime cruising) and Condition V (in-port) by organizational component (division)
- work parameters, including:
 - productive allowance as a percentage of the nonoperational workload by organizational component
 - make ready/put away allowance as a percentage of PM by organizational component
 - work multipliers which serve to vary any of the types of work on an organizational component basis
 - workweek including both productive workweek and service diversion and training by organizational component for each of the four categories of workweeks recognized by the model (watchstander at sea or in port, nonwatchstander at sea or in port)

The system applies the above factors in compiling the workload by organizational component and proceeds with the following steps in developing the billet requirements or SMD:

- (1) determine the number of billets required to meet watchstander requirements by division/rating
- (2) determine man-hours left available from those billets for work other than watchstanding
- (3) total the nonoperational workload (sum of PM, CM, FM and OUS) by division/rating and compare against the results of (2)

- (4) if (3) > (2), divide the excess by the nonwatchstander workweek to determine the additional billets required by division/rating. Fractional billets are rounded up and the associated man-hours unused are accumulated for future reference (Step 10). If (3) \leq (2), the numbers of billets determined in (1) represent the initial estimate
- (5) check for special conditions provided for each rating. For example, the quartermaster (QM) rating has the following constraint: "when there are four or more QM billets, the senior billet will be indented as supervisor and will not be assigned to a Condition III watch"
- (6) create preliminary billet table for each division/rating and apply paygrade distribution from data base-stored tables. The billet table is a matrix showing for each of the billets (rows) determined in Step 4 the following data (columns): watchstation title(s), paygrade distribution rate, paygrade required by workload, primary and secondary NEC, watchstanding hours, special watchstation hours, work on watch, PM, CM, FM, OUS and total man-hours assigned. The next steps involve work assignments to each billet and are recorded accordingly in this billet table
- (7) assign Condition III watchstations by matching, if possible, the existing paygrades in the table with the minimum paygrades associated with the watchstations. Enter station titles, paygrades required and watchstanding hours in the appropriate column of the table
- (8) assign special condition watchstations in a similar way. When underway replenishment hours are assigned to a Condition III watchstation, the watchstanding hours are reduced by the underway replenishment hours

- (9) assign non-man-hour watches for Condition I (general quarters), IA (amphibious) and IM (minesweeping) by matching paygrades in the billet table
- (10) assign unconstrained man-hour watches, where unconstrained means that no specific division or rating has been specified for the watch requirement. The man-hours are assigned on the basis of specified priorities by division and the man-hours left available in each division/rating as determined in Step 4. (Consequently, Steps 1 thru 9 which are by division/rating, must have been completed for the entire ship prior to Step 10.) If insufficient man-hours are available, then additional billets will be created in the appropriate division(s). The man-hours left available are accumulated for future reference (Step 14)
- (11) assign PM and CM workload to billets by descending paygrade in the following order: NEC specified, no NEC specified, no rating specified
- (12) assign OUS workload by descending paygrade
- (13) assign FM workload by ascending paygrade, starting with junior grades
- (14) assign unconstrained workload in accordance with the man-hours left available by division/rating determined in Step 10
- (15) assign non-man-hours, unconstrained watches (I, IA, IM without division or rating specified) to billets which do not have already non-man-hour watches assigned

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recommended to reduce the duration and extent of changes required after ship commissioning to achieve full operational capability.

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